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Power Equipment of the Lumber Exchange Bldg.

POPPET VALVE ENGINES, HIGH SPEED D. C. TURBO GENERATOR, ELECTRIC ELEVATORS, FORM PART OF THIS INTERESTING AND WELL DESIGNED PLANT

IN THE HEART of the loop district of Chicago, at the corner of Madison and La Salle Sts., the Leander McCormick Estate has just completed the Lumber Exchange Building, which occupies the space formerly occupied by the Roanoke Building, the razing of which began in May of last year. The new building is 16 stories high above the street level, which is the maximum height now allowed by city ordinance, but is designed for an addition of 4 more stories, which will be built in case the law changes to permit the addition.

Equipment of the building is modern in every respect, and is designed for office purposes. Needless to say, the building has its own power plant, the feasibility of which has been demonstrated by M. T. Kimman, chief engineer of the McCormick Estate, in several other buildings, for similar purposes, in Chicago. In this plant, however, Mr. Kimman has introduced several new features which have been carefully planned and no doubt will meet with success.

The power plant equipment is located on the second and third basements, the boiler room floor being on a level with the Illinois tunnel. The steam generating equipment consists of 4 200-hp. Scotch marine boilers, each 96 in. in diameter by 17 ft. 8 in. in length. These

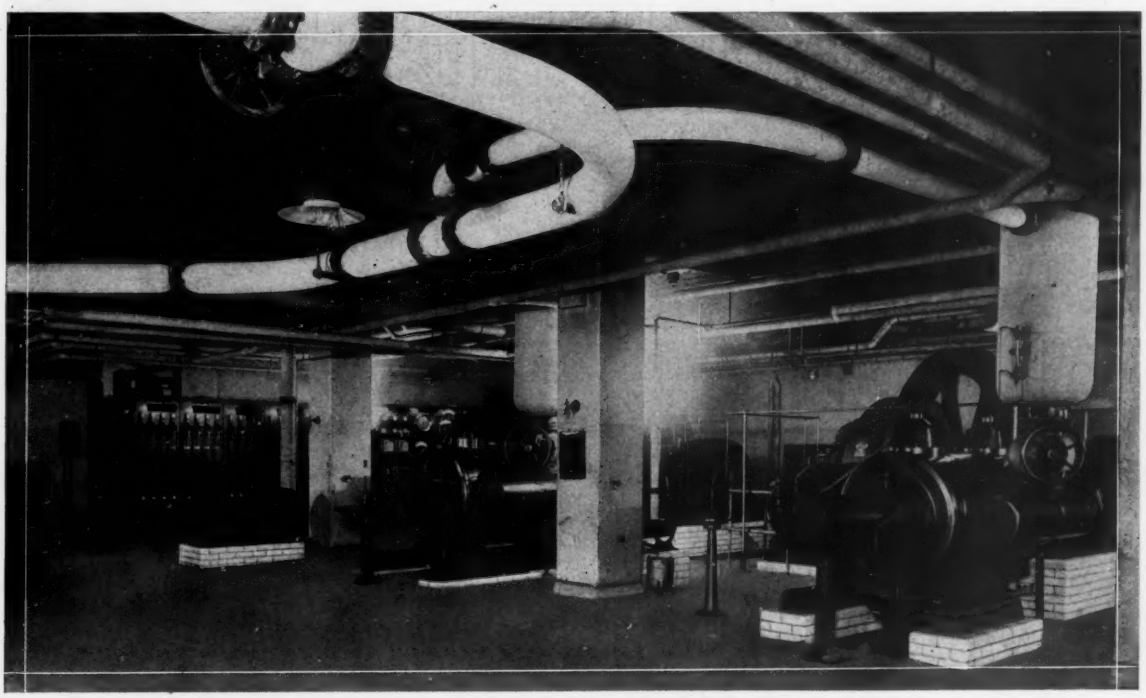


FIG. 3. VIEW IN ENGINE ROOM SHOWING ENGINE-DRIVEN GENERATING UNITS WITH SWITCHBOARD TO EXTREME LEFT

are built of 1-in. plates, and are operated at a pressure of 165 lb., but are built to withstand 200 lb. pressure in case it is desired. This course was taken in order to lengthen the life of the boilers, as it is calculated the pressure will not be cut down below 165 lb. as long as the boilers are fit for service.

Two Crosby safety valves, mounted upon one special fitting, are attached to the boiler, one of these being set to blow at 165 lb., the other at 200. This provision just ahead of the damper. This provision will enable the operators to examine furnace conditions thoroughly, in order that proper combustion may be secured. The entire boiler is covered with magnesia insulating material 2 in. thick, which effectively prevents radiation to the atmosphere.

These boilers are served by McKenzie Dutch oven furnaces, which are of the side feed gravity type, the grates being oscillated by means of a motor which drives

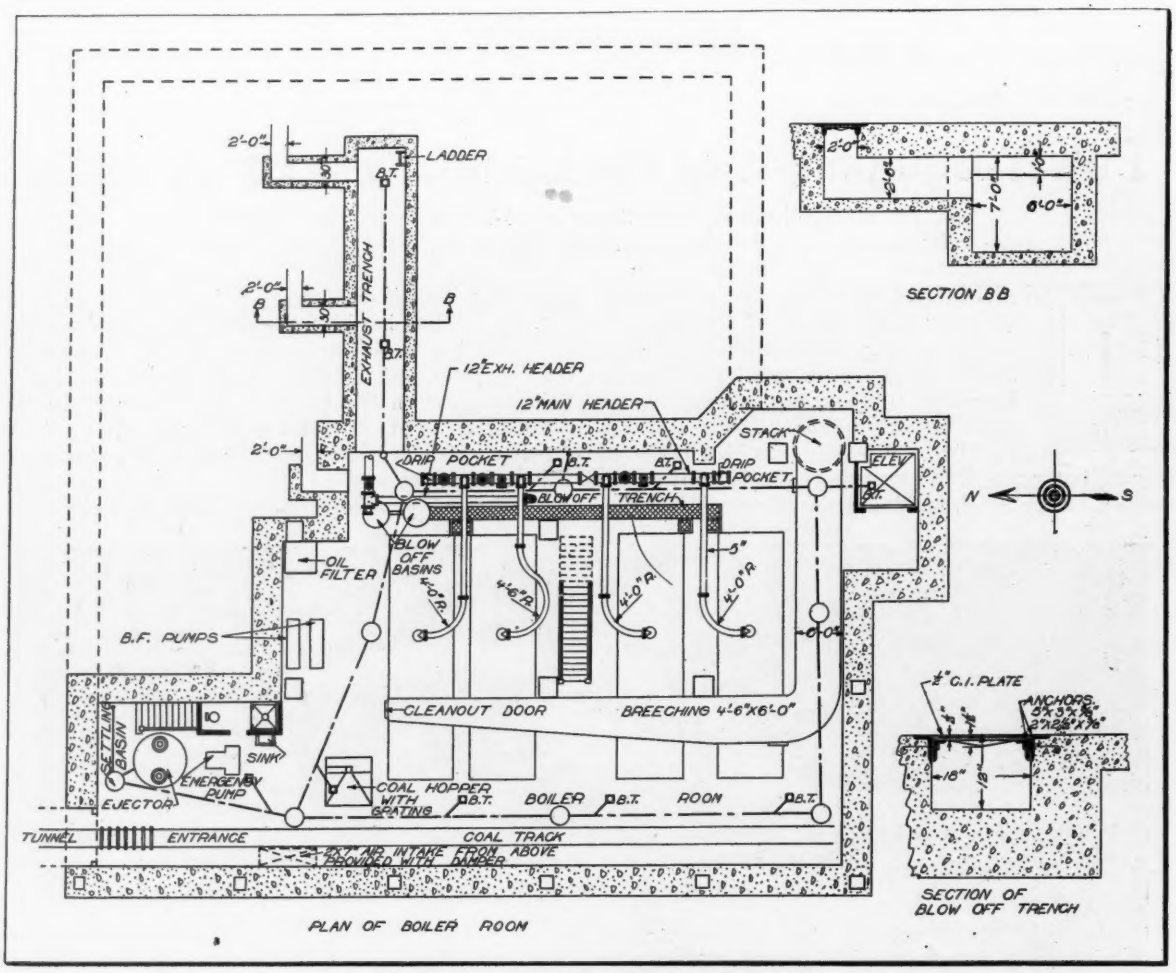


FIG. 1. PLAN AND SECTIONS OF THE BOILER ROOM

gets away from interference by any insurance company. Each boiler is equipped with 2 Diamond flue blowers, which are attached to the rear of the drums, and serve to keep the heating surfaces free from soot. Reliance safety water columns, with high and low alarm features, are mounted upon the boilers, gate valves being provided in the column connections, and a Crosby steam pressure gage is attached to the upper column connection and mounted upon the front of the boiler breeching, which extends over the furnaces.

Each boiler is equipped with an Ellison differential draft gage, which has 4 connections, one to a point beneath the grates, another to the furnace neck, a third to the rear of the boiler and the fourth to the breeching

the line shaft for 2 boilers, couplings being used to connect the shafts for 2 stokers, thus only 2 motors are used for the driving of the stokers. The furnace is connected to the boiler by means of a firebrick-lined steel neck, which makes the furnace entirely separate from the boiler, and reduces materially the amount of masonry work in the boiler room. Around the firebrick in the connection is a coil carrying water, which is designed to lengthen the life of the firebrick.

Coal and Ash Handling

As there is no alley adjacent to the building, coal is delivered to the plant from La Salle St. through chutes to bunkers over the furnaces; or it may be de-

livered to the plant by means of tunnel cars, which are dumped into the hopper of a combined V-bucket elevator and scraper conveyor to the bunkers. The latter method, however, will be used only in case delivery from the street is impossible for a considerable length of time. The capacity of the bunkers is 200 tons, and the consumption of the plant will, at maximum load, be in the neighborhood of 10 tons a day, so that with the bunkers full, the plant will have sufficient fuel for 20 days' run at full capacity.

From the bunkers, the coal is discharged into a traveling hopper scale, where it is weighed and then delivered to the furnace as required. Provision of a traveling scale makes it possible to deliver coal from one end of the bunker to a furnace at the other, and necessitates provision of only one scale. The entire coal-handling system is the design of the Webster Engineering Co., of Chicago.

Ashes are shoveled from the ash pit into tunnel cars, which dispose of them through the Illinois tunnel.

Natural ventilation is provided for the basements occupied by the power plant, as air for the furnaces is drawn partly through the engine room to the boiler room, and partly down around the smokestack direct to the boiler room. This system keeps the engine room comparatively comfortable at all times in the year, and provides sufficient air for combustion of the coal.

Combustion is controlled by a hand damper in each boiler breeching, supplemented by the main stack damper. As will be noted in the illustration, the breeching is directly over the furnaces in front of the boilers. The height of the stack is 320 ft., giving ample draft supply for the furnaces.

City water is used for feeding the boilers, being delivered to the feed water heater as makeup water, in addition to the returns from the heating system. An open type Cochrane bypass heater is located in the engine room, and is supplied with exhaust steam from the main exhaust pipe by induction. On its way to the boilers, the water is passed through a Cochrane V-notch meter and recorder, which is so piped that it may be used to measure the returns from the heating system or the water used for house purposes when not measuring the feed water to the boilers.

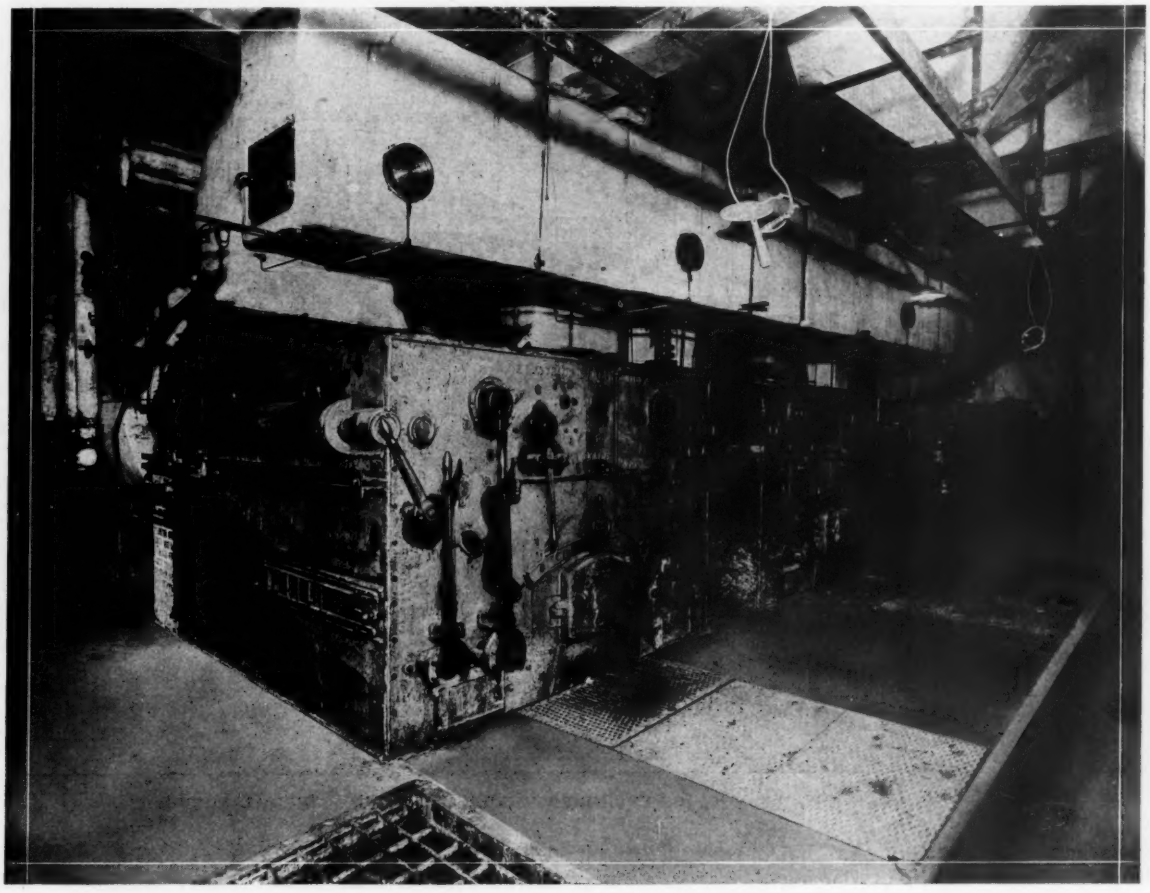


FIG. 2. GENERAL VIEW OF THE BOILER ROOM

Two boiler feed pumps are located on the boiler room floor, and are so piped that they may feed through either of 2 lines to the boilers. These are American simplex pumps, 10 by 6½ by 12 in. each. Aside from the 4 main boilers, a small Kewanee rubbish boiler is installed in the plant for burning all sorts of waste from the

offices, and is used to heat water for the building.

Sewage from the basements below the city sewer line is drained to a sump pit in the boiler room, from which it is pumped by means of a Yeoman duplex ejector, or, in case of emergency, by a 6-in. Worthington centrifugal pump driven by a Wait Bulldog turbine.

In the engine room on the second basement are the main generating units, consisting of 2 Nordberg engines, direct connected to Crocker-Wheeler generators, and one Wait turbo-generator. The latter unit, however, is not yet in operation, but will be, within a few weeks.

The engine-driven units are of 300 and 200-kw. capacity, generating direct current at 230 v., the speed being 150 r.p.m. The interesting feature of these units is the fact that the engines are of a poppet valve type, the gear and governing mechanism of which are the first to be installed and put into operation in this country.

The cylinders are of plain form, without steam or exhaust chests, which arrangement avoids distortion under high superheat, while the cylinder heads are cast separately from the cylinder proper and contain the valves. This construction is such as to steam jacket the heads thoroughly, and the ports are carefully proportioned to reduce friction of the steam. The back cylinder head is supported on rails, permitting it to be easily removed and give access to the piston and interior of the cylinder. The cylinder is also provided with relief valves, drip cocks and indicator pipe connections.

Steam and exhaust valves are of the double beat, balanced poppet type, carefully ground and fitted to their seats, which are removable and ground to fit the cylinder head casting. The valve stems are grooved to form a water packing so that no stuffing-box or metallic packing is required.

All valves are operated from a revolving lay shaft, driven through bevel gears from the main shaft, which is parallel with the cylinder. An eccentric on this shaft oscillates a cam which positively opens and closes the poppet valves without the use of springs. The lay shaft also carries an inertia and centrifugal governor to control cutoff.

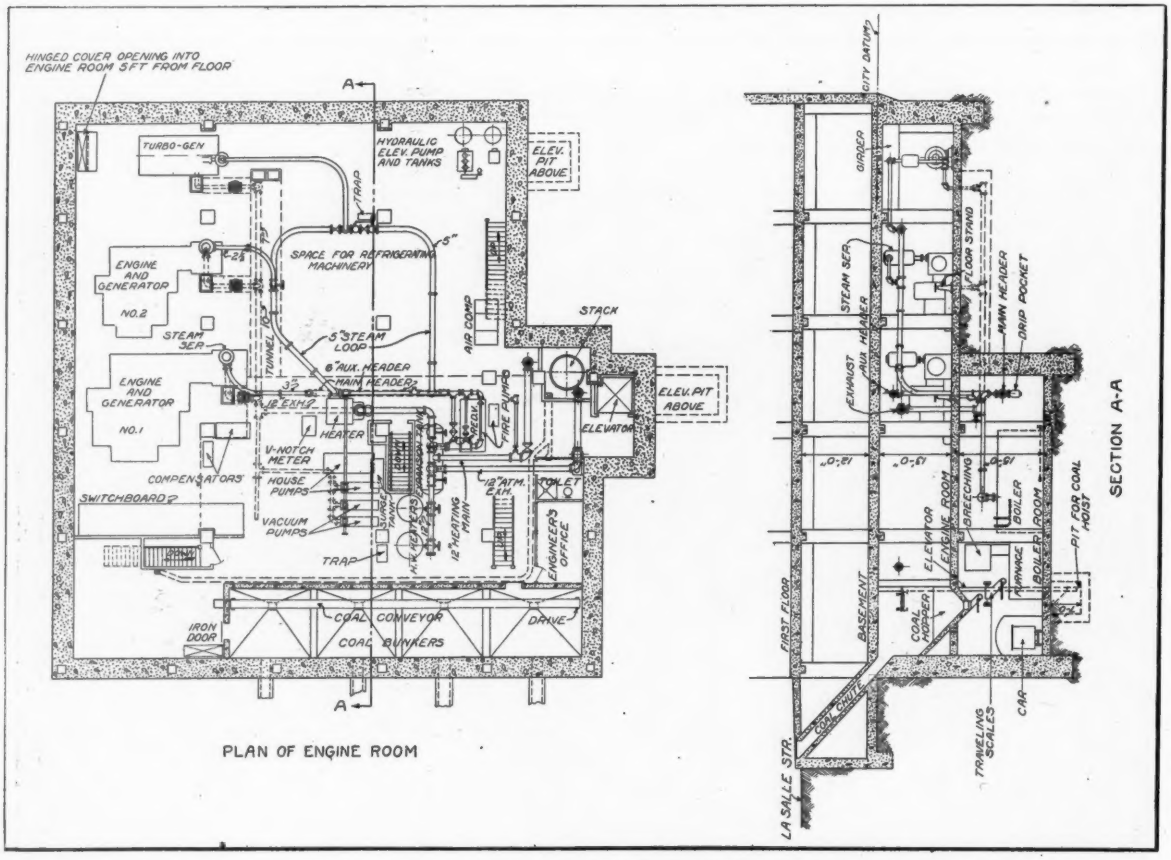


FIG. 4. PLAN AND ELEVATION OF ENGINE ROOM EQUIPMENT AND PRINCIPAL PIPING

As will be noted from the photographs, the frame of the engine is of the heavy duty type, containing the main bearing and the slides in one casting. The exterior form of bed is smooth, all ribbing and reinforcing being done at the core on the inside of the casting. The slides and the flange on which the cylinder head is centered, was bored at one setting, thus insuring perfect alinement. These engines are equipped with an automatic oiling system, with a Richardson-Phenix filter and purifier in the boiler room.

The load upon these generators is exceedingly variable, as a great share of the output is used for driving

electric elevators. It is hoped by this combination of generator and engine to secure the best possible regulation of voltage.

The turbine unit was especially designed for this plant by Henry H. Wait, and consists of a single stage turbine, driven at 2200 r.p.m., connected to a 100-kw. direct-current generator, which delivers at a voltage of 230. The turbine is made with a single wheel, having buckets placed radially around its outer edge, and the steam passes through the buckets in a direction parallel to the shaft. The pressure energy of the steam is first converted into velocity energy in an expanding nozzle. The steam passes out of this nozzle into the wheel at nearly exhaust pressure. After passing through the wheel and giving up part of its energy, the steam is returned to the wheel again, when it transmits to the wheel the remaining part of this energy. By this means, a high efficiency can be obtained at comparatively low speeds.

Expanding nozzles are of bronze, and are first reamed out with circular reamers and then shaped by driving in formers which make the discharge end of a curved contour to fit the wheel and the throat of the nozzle of a suitable shape to deliver the steam most efficiently to the exit end. The nozzles are screwed into a cast-iron seat, which is bolted to the front cover of the casting. Each nozzle is provided with an independent hand-operated shutoff valve, so that the efficiency of the machine can be maintained at light load.

Packing is made up of carbon rings with spiral springs holding the packing to the shafting, and a flat disk spring between the rings to keep them against the casing. The packing box is, also, provided with a steam seal.

Bearings are babbit lined with ring oiling, and are water cooled. The casing is made of cast iron, split vertical. Around the inside of the cover is cast a circular passage, detached from the cover except in 4 spots, where the nozzle valves are located. This construction is such that this passage is the only part of the casing subjected to high steam pressure, and in the event of using superheated steam, the high temperature does not tend to distort the casing.

The speed is controlled by a centrifugal spring-weighted type governor, mounted directly on the end of the shaft. The governor operates on a double beat balanced throttle valve, and is designed to regulate the speed of the turbine to 2 per cent variation from no load to full load. The governor is provided with a hand adjusted supplementary spring for adjusting the speed when the turbine is running. The thrust bearing on the governor sleeve is a ball bearing, and along with the rest of the governor is oiled by a special device incorporated in the main bearing. The throttle valve is provided with a steam strainer which can be removed and cleaned.

In addition to the main governor, an independent device for completely shutting off the steam, should the speed through any cause become excessive, is provided.

While the turbine element of this unit represents a number of individual features, it is a comparatively simple matter compared with the design of the generating element. The centrifugal force at the periphery of the armature amounts to nearly half a ton per pound of material, and it can readily be understood that the designing of a machine to hold a large number of small insulated coils, with an adequate factor of safety, and so placed that they will stay where they are put and not unbalance the machine, is a problem of considerable difficulty.

The armature resembles an ordinary ironclad armature, except that everything has to be made stronger, and the shaft at the center is very large so as to bring the critical speed well above normal. At the ends of the winding where there are no teeth to hold the coils against centrifugal force, non-magnetic retaining rings

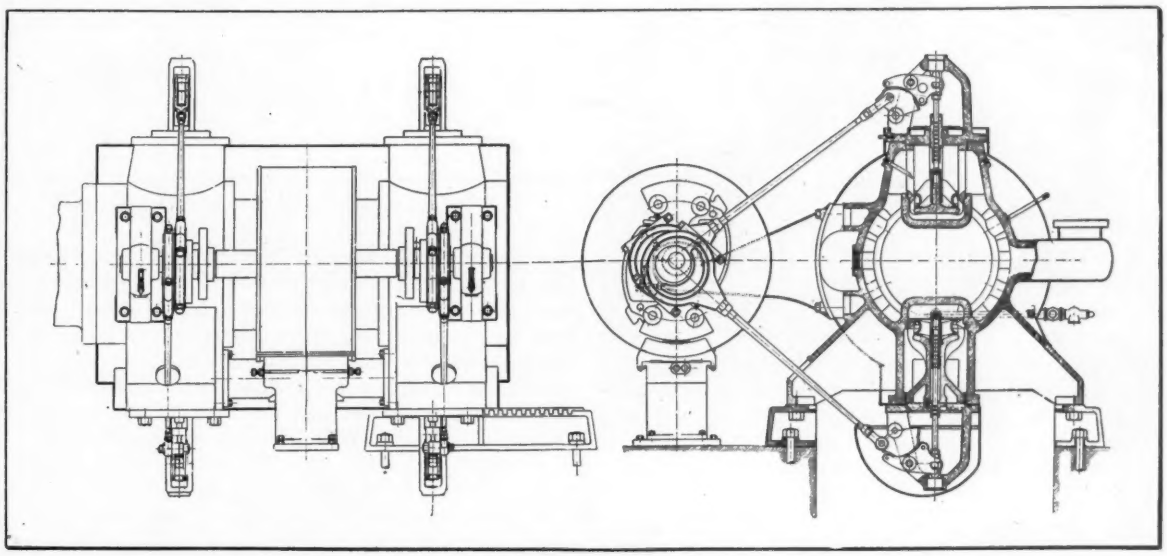


FIG. 5. LONGITUDINAL ELEVATION AND CROSS SECTION OF POPPET VALVE ENGINE

are used, which give a very large factor of safety in spite of the enormous strains.

Abnormal peripheral speed limits the size of the commutator diametrically, and the great coefficient of expansion of long commutator bars limits the permissible length in a longitudinal direction. The segments are held against centrifugal force by nickel steel retaining rings, which are shrunk in place to give a large factor of

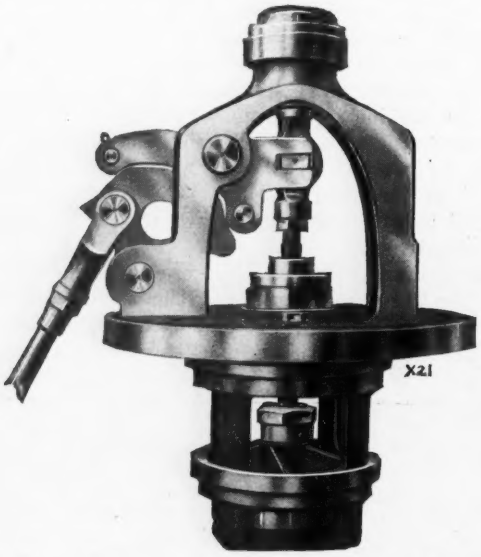


FIG. 5A. POPPET VALVE AND GEAR USED IN NORDBERG ENGINE

safety to the commutator, and the construction is such that the bars may expand considerably in length without distorting the shape of the commutator.

In order to overcome the effects of high commutating voltages, caused by the large current and high speed, commutating poles are used. The rest of the field structure is of the same general character as on ordinary machines of 4-pole construction.

engines, when they are running at the required load, but in the winter time, in stead of turning live steam on to the building, it is the intention to run the turbine as a reducing valve, and thus secure the benefit of all

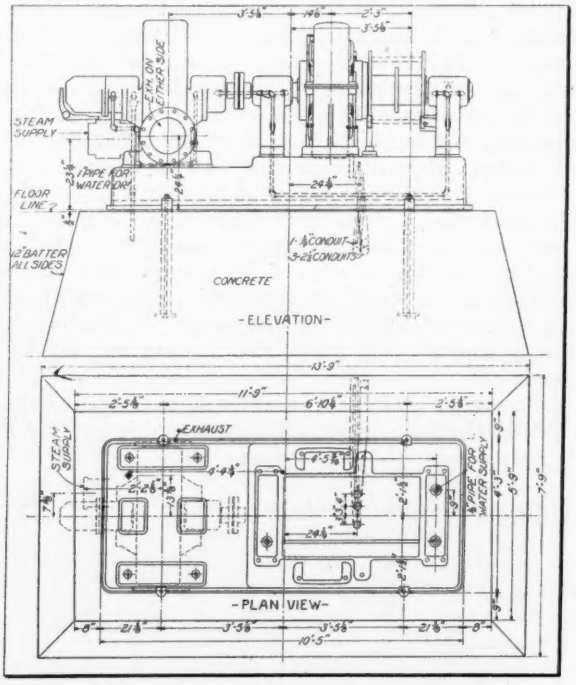


FIG. 6. PLAN AND ELEVATION OF TURBINE UNIT

power in the steam used for heating purposes. The idea that live steam at reduced pressure is not as efficient for heating purposes as exhaust steam, has long been prevalent, and in this plant an opportunity will be given to demonstrate this idea thoroughly.

The building is wired for the 3-wire system of lighting, and in order to keep the load on the generators balanced, 2 Crocker-Wheeler balancer sets are installed.

FIG. 7. EXTERIOR VIEW, BUCKET WHEEL IN CASING AND NOZZLES OF TURBINE

It is the idea, in the operation of this plant, to use the reciprocating engines as long as the demand for exhaust steam does not exceed that delivered from these One of these runs at 1600 r.p.m., at 115 v., and has a capacity of 20 amp. The other runs at 1150 r.p.m., with a capacity of 40 amp.

Switchboard

Another distinctive feature of this plant is the type of switchboard which has been installed. This consists of 12 panels, 3 of which are for the generators, and upon them are mounted 3 double throw switches connected to negative, neutral and positive buses, a rheostat hand wheel, pilot lamp, Weston ammeter, and circuit breakers. The next 2 panels are for the compensators, and upon each of these is mounted 2 4-pole switches, one starting switch, a contact maker, pilot lamp, Weston ammeter with double dial, and upon one of the panels are mounted 2 voltmeters on one bracket, while on the other panel is the clock.

Next to the compensator panels is the totalizing panel, upon which are mounted 6 integrating wattmeters, one graphic voltmeter, and one graphic ammeter. The other 6 panels contain the circuit breakers for distributing current throughout the building. These are the distinctive features of the switchboard, as this part of the board is not provided with bus bars or fuses, the ITE circuit breakers eliminating this part of the ordinary switchboard. Those circuit breakers feeding the lighting circuits are the 3-pole type, while those for power are of 2 pole. The builder of this switchboard is the Cuthbert Electric Mfg. Co.

The main gage board of the engine room has mounted upon it Crosby pressure gages, consisting of instruments to indicate boiler pressure, feed water pressure, record-

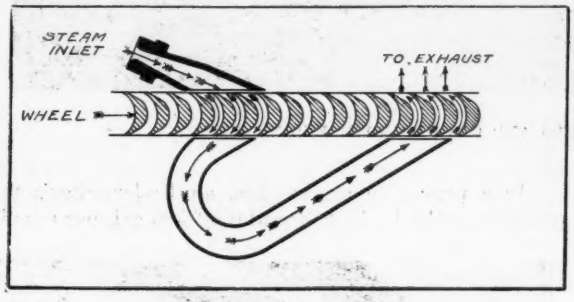


FIG. 8. DIAGRAM SHOWING FLOW OF STEAM THROUGH NOZZLES AND WHEEL

ing steam pressure, recording back pressure, vacuum on heating system, and house tank pressure. There is also a clock and a Bristol recording thermometer which gives the temperature of the feed water on this board, which was erected by the L. H. Prentice Co.

Elevators

As has already been stated, the principal load upon this plant is the electric elevators, of which there are 6, all Otis 1 to 1 traction type, driven by motors in the pent house, where the controlling switches are also located. These elevators are all equipped with safety stopping and starting features, which prevent the elevator from starting until the gates are closed, and stop the elevators when the lever of the car is released by the operator.

Besides the main electric elevators, one hydraulic lift operates between the first basement and the main floor, the machinery for which consists of a Crocker-Wheeler motor of 5 hp. capacity, driving a Deane 4 by 6-in. triplex pump, with pressure and surge tanks in one corner of the engine room.

An air compressor, the product of the Chicago Pneumatic Tool Co., and close driven by a belt from the motor, is used to compress air for cleaning purposes about the engine and boiler rooms. The size of this compressor is 8 by 8 in., and the motor is automatically controlled to maintain a constant pressure by a Cutler-Hammer control system.

Piping System

Another important feature of this plant is the elaborate system of steam piping, which gives flexibility in the use of steam and is convenient in testing any steam-driven unit independently of others. Steam is conducted to the main header in the basement through long radius horizontal bends. The main stop valve is of the angle type, directly over the boiler, and at the header, a gate valve is provided, making 2 valves from the boiler leads. The main header is short, and at each end is a receiver which drains to Crane tilt traps.

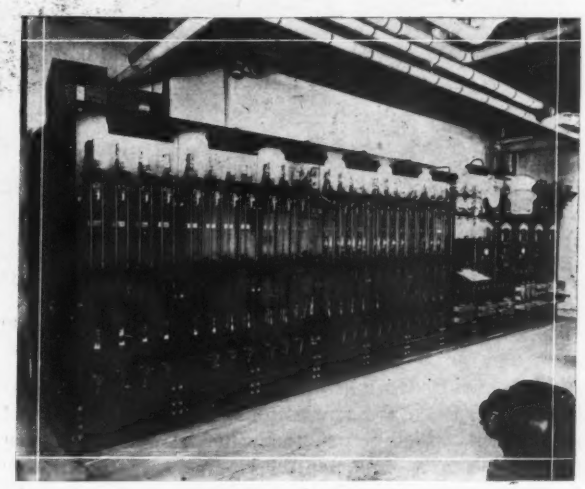


FIG. 9. GENERAL VIEW OF THE SWITCHBOARD

The main steam loop in the plant feeds the turbine and small reciprocating unit. The ends of this loop lead from the upper side of the main header to the ceiling of the engine room, and the loop is so valved that tests may be run on either of the units without interfering with the operation of the rest of the plant.

A special lead is taken to the large generating unit from one end of the main header. The auxiliary header is carried on spring supports from the engine room ceiling, and connected by 2 lines direct from the main header in the boiler room. The auxiliary header feeds all pumps, and supplies live steam when needed to the heating system.

A noticeable feature in the piping is the small size employed, while at each of the main units a receiver separator of large capacity is placed directly over the throttle valve. Main piping is figured for steam velocity of 8000 ft. per min., at 25 per cent overload on the engines.

Exhaust from all steam-using machinery is taken to

a header in the basement, from which it rises through an oil separator to a bypass heater and the expansion tank. From here it is either taken to the heating system or to atmosphere, through a Cochrane multiported back pressure valve, or to the house hot water heaters.

The heating system is of the Van Auken vacuum type, with the main header in the attic. The vacuum is maintained by 2 Blake & Knowles pumps, each 8 by 12 by 12 in. simplex, which return the water to the heater. In order to feed live steam to the heating system, 2 Foster reducing valves have been provided, one 1½ in., the other 4 in., and besides these, a 1½-in. bypass pipe is provided for emergency use.

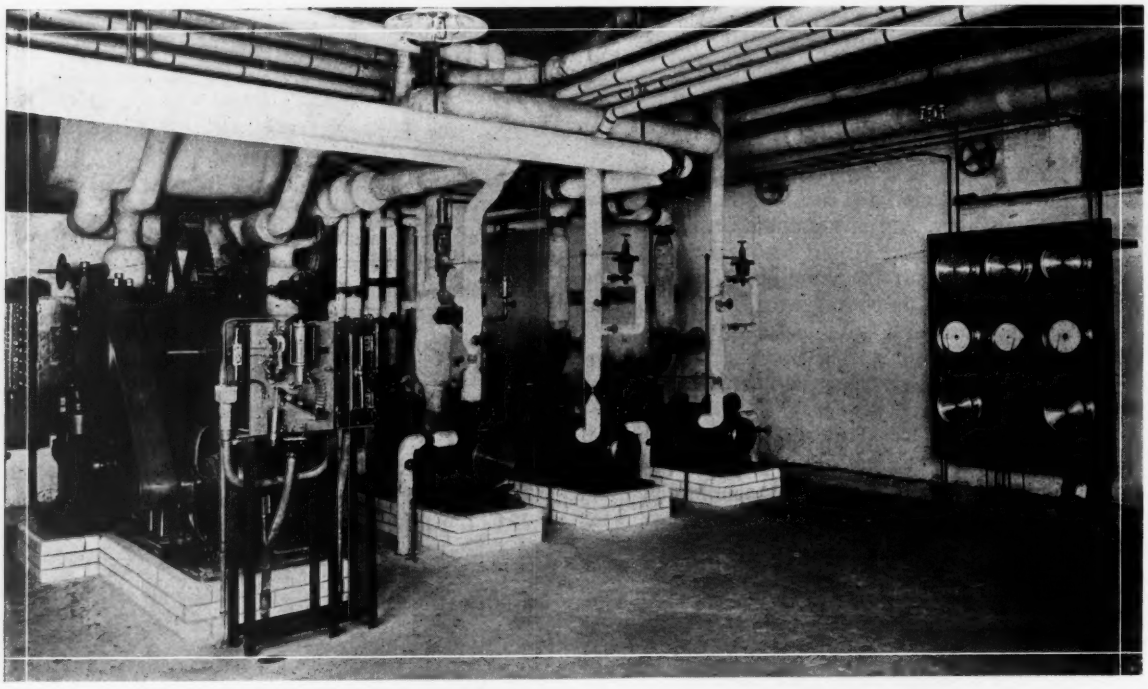


FIG. 10. HOUSE PUMPS, VACUUM PUMPS AND GAGE BOARD IN ENGINE ROOM

The main house pump delivers to a tank in the attic. This is a Deane triplex 8 by 8-in., driven by a Crocker-Wheeler motor through a short belt drive with a lifting idler. The pump is provided with a rawhide pinion, which makes it almost entirely noiseless in operation, and the motor is controlled by a Cutler-Hammer automatic system, which maintains the level in the supply tank.

Hot water used about the house is heated by the rubbish boiler and in 2 tanks by exhaust steam. The temperature of the water is controlled by a Powers temperature regulating system, and the heating coils are drained by means of a Crane-tilt trap in summer, while in winter 2 Dunham traps will be used. This hot water is circulated through the building by an American simplex pump 10 by 6½ by 12.

As previously mentioned, the ventilation of the engine room is carried on naturally by the provision of a duct from the northeast corner of the engine room to the street, through which air is drawn to the boiler room through the stairways, one back of the switchboard, the other leading down between the boilers.

The first basement is provided with an exhaust fan, which is motor driven, while all toilets in the building are ventilated by means of a motor driven Sturtevant fan located in the attic.

As a protection against fire, an Underwriter's fire pump, made by Blake & Knowles, of 500 gal. per minute capacity, with dimensions 14 by 7¼ by 12 in. duplex, and at a speed of 70 r.p.m., is provided. An auxiliary pump of the same make, 6 by 4 by 6 in., maintains the

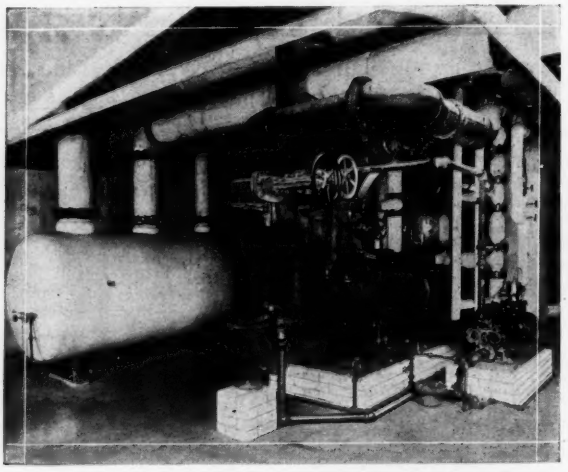


FIG. 11. FIRE PUMPS AND EXPANSION TANK

pressure in the lines at all times except when water is needed for fire purposes. The first basement is provided with a sprinkler system for fire protection. The pumps are under the control of Fisher governors, to maintain the desired pressure on the system. On each floor, a hose of proper size is provided, and the McFell system of fire alarm is installed throughout the building. Aside from the pumps in the basement, a street connection is made for the City Fire Department to connect to.

To provide a protection for the generators and switchboard from a flooded first basement, the ceiling over these machines is made waterproof, so that no injury can come to the electric apparatus, due to the sprinkler system on the first basement opening up.

In the Department of Mechanical Engineering of the University of Illinois, which has been developing work along the lines of heating and ventilation under the direction of Professor A. C. Willard, a recent addition to the considerable amount of equipment for the experimental study of heating and ventilating problems consists of a Type A Air Washer and Humidifier made by the Warren Webster Co., of Camden, N. J. This apparatus is especially arranged for experimental purposes, so that complete control of the volume and temperature of the water circulated and of the air passing can be maintained. The washer is equipped with a double bank of spray nozzles which by means of a finely divided mist wash the air passing and also cool and humidify it. After passing the nozzles, any entrained water in the air is removed as the air passes through a double row of V-shaped eliminators. The washer has a capacity of 3150 cu. ft. of air per minute at a velocity of 450 ft. per min. through the spray chamber. The spray water is circulated by a motor-driven centrifugal pump.

When humidification is desired, it is necessary to saturate the air leaving the washer, and for this purpose a steam and water mixer of the injector type is installed in the tank below the spray chamber. The operation of this mixer is made to depend upon the temperature of the entrained spray water leaving the eliminator plates. A Powers water temperature regulator is placed in the path of the discharge from the eliminators, and this regulator automatically operates a pneumatic diaphragm valve in the steam line leading to the mixer. Since the temperature of the saturated outgoing air and of the entrained spray water will be the same as they leave the eliminators the Powers regulator maintains a definite temperature of outgoing air of known humidity (100 per cent).

The temperature of the outgoing air is also under the control of a Johnson duct thermostat which operates the pneumatic diaphragm valve supplying steam to a tempering coil placed in the inlet to the air washer. This coil makes it possible to preheat the air and determine the cooling effect or "humidifying efficiency" of the washer over a wide range of entering air temperatures. As an air washer or cleanser this apparatus is guaranteed to remove 98 per cent of all solid matter contained in the entering air. The flow of air through the washer is induced by a No. 4 Sirocco multi-bladed fan with a 24-in. diameter rotor. This fan is driven through an Olsen transmission dynamometer by a variable speed motor.

A "Cat"astrophe

Eulogy on the Powerhouse Cat Which Departed for the Golden Shore Without Premeditation, Leaving Hosts of Sorrowing Friends. By Geo. H. Wallace

THERE'S sorrow today on the engineer's face,
The assistant with sadness looks queerly.
And fireman John, like the feminine race,
Sheds tears in abundance sincerely.

The Armenian coal passer weeps with a will,
And splashes of brine lay the dusty confusion.
The ashman sits down on his barrow so full,
And sheds bitter tears in reckless profusion.

Half risen, the flag on the staff idly toys,
O'er the roof of the office, a visible token,
In which the departed, dumb friend of the boys,
Is held, though the words we would say are not spoken.

The kitten would romp with the small bits of coal,
And bury herself with a bound in the shavings.
She'd race through the power house, with many a roll,
And be carefree and gay in her ravings.

She performed with delight, little tricks such as we'd
After weeks of persuasion, most thoroughly taught her.
But she jumped through the flywheel at maximum speed,
When a spoke, fast revolving most fiendishly caught her.

"Come back, little kitty! Come back once again!
Come play with your catnip and toys as of yore.
Come spar with the shadows, the governor casts,
From the sizzling arc light down onto the floor.

"Come back here among us and share in our victuals,
As at noon we eat hastily, chatting and smoking.
Come purr in contentment while Jake calmly whittles
And Jens draws the sparks from thy black fur by stroking."

Alas! She has gone to that mystical shore,
Where at night on the fences that glitter with gold,
She can fight other kittens as she oft has before,
And can fight on forever till ages grow old.

Bagging and Buckling Boilers

SOME INTERESTING FAILURES AND CAUSES GIVEN. BY CHAS. J. VEDDER

MUCH has been said and written on the subject, and it would seem that engineers would get wise; but the frequent occurrence of baggings, and especially that of buckling the plate over the fire, shows that it is not so well understood as it might be, and in nearly every case the boilers were in charge of well informed engineers, therefore it must be charged to carelessness rather than to ignorance.

Having had 15 yr. experience as operating engineer, and 20 as Inspector of Boilers and Examiner of applicants for engineer's licenses (being still employed in that capacity), I speak, therefore, mainly from personal experience.

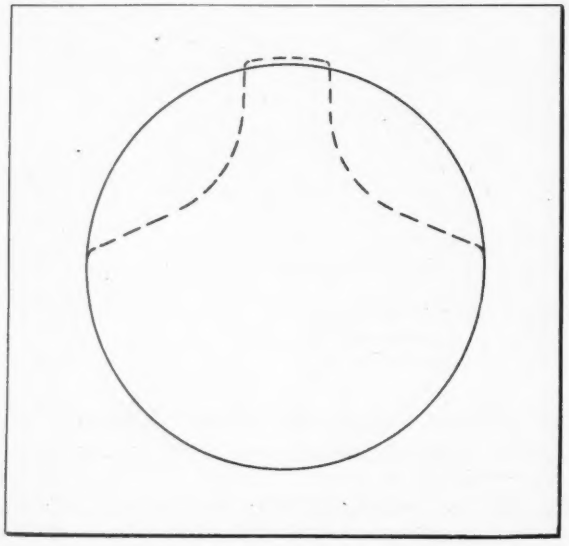


FIG. 1. FLUE COLLAPSED BY LIFTING OF WATER

The bagging of a horizontal externally fired boiler may take place anywhere from the front to the rear head, and invariably is caused by some foreign substance, generally scale, mud, oil, sand, and I have found gunny sacks, cotton waste, sawdust and at one time a piece of carpet. All of the above have a tendency to bag the plate. I have found other things in a boiler, such as rulers, pocket-knives, cold-chisels, hammers, wrenches. Such articles will not bag a boiler, but show carelessness.

As a rule, bags appear over the fire, and the small bag is the most dangerous, especially when it comes down over a small area, that it cracks in its deepest part, allowing a small stream of water to escape into the fire. It is often the first warning that the engineer has that a bag is forming. The question often asked is, "Why does not the bag continue to go down in every case until a rupture occurs?" The reason is that when the plate begins to go down by overheating, the scale, mud or other substance breaks up, admitting water; violent ebullition takes place, throwing the deposit back into circulation but will settle back when the boiler is cooled, for I never yet have opened a bagged boiler but that I found the bag filled as stated. The largest bag I ever saw was on a boiler used in a sawmill, a 54-in. by 16-ft. The bag was at the rear end, and evidently discovered in time as the rivets had partly sheared and holes stretched oblong; it was filled with sawdust, mud, grease, scale and a gunny sack. The bag would have answered for the bottom of a large sized wheelbarrow.

Buckling of a boiler plate is altogether a different thing and results from a different cause, yet many engineers make no distinction between bagging and buckling and take both to mean one and the same thing. If the reader will close his hand and feel over the knuckles he will get a good idea of what I mean by a "buckled boiler plate." Of course, the buckles are not so uniform, are larger, deeper and farther apart. They always appear over the fire, and in bad cases make the bottom of the boiler appear like a corrugated flue.

If the curvilinear seam is near the bridgwall and badly affected by warping, will leak badly, calking and riveting will do little good to make it tight. Cutting out is the only remedy; but if not affected and buckles not very large, the boiler may be left in service, but generally at reduced pressures, and also will have to be kept free from scale and mud as deposits are likely to settle in the depressions and cause further damage. In every case, oil is given as the cause, yet, in every case that I have seen, no trace of oil was found in the affected part, and often not a trace in the entire boiler. The reason given for no trace of oil is that it was burned up when plate got hot. I have scraped the sticky oil from the sides, tubes, heads, with the bottom not free from it by any means, and boiler operated every day and no bag or buckle ever formed, although I fully agree that oil is a bad thing in a steam boiler and will cause bags, and large ones, too.

And right here I will quote the old story of the engineer who, washing out his boiler, left a small piece of candle not over 1½ in. long in the boiler. The next morning a large bag formed over the fire; opening the boiler again, he found that the candle had melted and formed the bag. No doubt the reader will smile, but it is well to keep candles out of a steam boiler.

I dare say that 2 conditions must necessarily exist in a clean boiler to buckle the plate,—an intensely hot fire and a sudden, or at least a rapidly falling pressure. For an illustration, take a 5-lb. tin pail half full of water, set on a hot stove. It soon will boil; add more heat and it will boil over, although we have not added a drop of water. Why? Because the heat applied is so intense that the water is turned into steam bubbles, globes or spheroids so fast that, in escaping through the water to the surface, it displaces a sufficient amount of water to raise it enough to boil over. If a steam-tight cover were now placed on top of the pail, a pressure would begin to build up at once, holding the water down,

but if removed a few minutes later the water would boil over more violently than before, owing to the fact that the temperature had been increased, but more especially because the pressure had been removed. If the heat were still continued, the bottom of the plate or pail would buckle for the reason that the heat applied could not be absorbed fast enough by the water on account of the condition stated, and if oil is present the conditions described above are intensified.

In most cases that have come under my observation, the buckling happened on boilers used for power and heating combined, where a reducing valve is used in the main steam pipe, the pressure carried in the boiler from 40 to 80 lb., and the pressure on the heating system from 1 to 15 lb. The trouble nearly always occurs in the morning, and can only be explained as follows. The engineer is late, fires are built and urged, and as soon as the gage shows 20 or more lb. the vacuum pump is started to remove the air from the heating system. Then the main steam valve, often 5, 6 or more inches in diameter, is opened, and, instead of taking plenty of time, half an hour or more, it is wide open in less than a minute, and fires still urged. The steam at a pressure, not likely over 30 lb., rushes into a vacuum and pressure falls rapidly, the water is driven from the plate, not like an umbrella, but is turned into the spheroidal state, like water on a red hot stove, and the damage is done before the reducing valve goes into action.

Recently I was called to look at a boiler that was badly buckled over the fire, a 48-in. by 14-ft. boiler in use 5 yr. and used only for low pressure steam heating, pressure never exceeding 15 lb., water of condensation returned by gravity. The buckling was done as follows: The engineer, or rather janitor, started to burn a lot of refuse, creating a very hot fire, getting the building too warm. He was ordered to shut steam off for a time. The pressure ran up, safety valve began to blow hard, then the janitor, having 2 boilers in the setting, opened up the steam valve between the 2 to stop the noise. An hour later, when he attempted to build another fire he found the bottom of the boiler over the fire looked like a corrugated flue, and it was not oil deposits or low water that caused it, but the lifting of the water by the sudden reduction of pressure and a hot fire in the furnace.

Now, a few words in regard to the peculiar collapses of plain flues will not be amiss, especially such as have come under my observation. I am speaking of flues 8 ft. long, 25 in. in diameter, 5/16-in. steel, 60,000 lb. tensile strength, single-sheet, single-riveted seam in the bottom and supported at the ends only where they are riveted to the heads. In 2 cases, the flues collapsed in identically the same way, the entire length of flue, but heaviest over the fire, the grates extending 5 ft. in the flue. See Fig. 1. One of the boilers was new. The other had been in use 5 yr., carrying from 90 to 100 lb., safety valve set at 100. The boilers were used at different times for steam drills requiring heavy firing; in fact, the boilers were too small for the work.

The first cause given for collapse was low water, but as the smaller tubes above the large flue showed no signs of leakage, and furthermore, if caused by low water, why did the flue not collapse from the top? The first cause, therefore, could not be maintained. Then the cause was given as deposits, but none were found; then overpressure, but that too is not tenable as steam gages and safety valves were in good order, although by some authorities 100 lb. pressure is rather high for the flues. Joshua Rose, in his work on steam boilers, speaks of flues in marine boilers collapsing at the side and gives method of construction and staying as possible cause, but that can hardly apply to the flues mentioned. It seems to be a plain case of repulsion of the water, caused by a rapidly falling pressure and an extremely hot fire, and when it is considered that the grates are placed nearly ⅓ up in the flue, adding 8 or more inches of incandescent fuel, we shall have the greatest heat where the flue collapses.

I have heard engineers argue that the reason the flue collapses at the sides is because the upper part gets red hot, by low water or deposits, and the pressure being greatest at the sides, collapses, springing the weakened part up. They certainly are in error. The pressure is equal at all points, and the upper part getting red hot would collapse in line of least resistance downward, as the following will show.

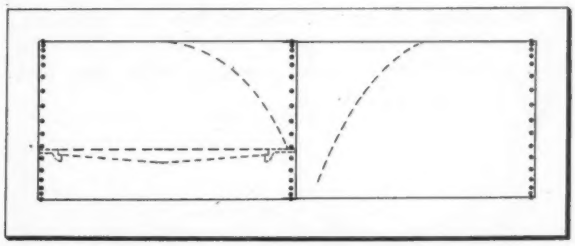


FIG. 2. FLUE COLLAPSED DUE TO SCALE ON TOP OF FLUE

In a railway construction camp I found the engineer replacing the handhole plates on a horizontal center-flue return tubular boiler, flue 25 in. in diameter, 5/16-in. plate, 60,000 tensile strength, 8 ft. long, built up of 2 sheets with curvilinear seam in center, and longitudinal at bottom, single riveted. Looking into a handhole, I saw considerable deposit on top of the main flue between 2 smaller tubes. I drew the engineer's attention to it and warned him against a collapse. He claimed lack of time to remove it. The next day the flue collapsed, not on the sides, but from the top downwards, shearing the rivets and crushing one of the plates down to the grates, the other within a few inches of bottom of flue. See Fig. 2.

Foaming and priming, or the lifting of the water, caused by sudden demands for steam or heavy firing, and aggravated by impurities in the water, are quickly noticed by the engineer and counteracted by partly closing steam outlets and dampers, therefore, as a rule little or no damage is done to the boiler, but may have serious results in other parts of the system.

Again, engineers are often called on to shut down unexpectedly; all outlets of the boiler are shut off, dampers partly closed, pumps or injectors are also stopped, no circulation, heat bottled up. This condition remains for 10, 20, 30 min. or longer, then a sudden call for steam, and unless the engineer uses extreme care in opening steam valve, dire consequences may follow, if not an explosion.

Dry Pipe Sprinkler System

DIFFICULTIES ENCOUNTERED AND OVERCOME IN OPERATION. BY R. A. CULTRA

WITH the dry pipe sprinkler system, there is much trouble experienced in some plants by the small air leaks which allow the water to creep into the air pipes undiscovered. This is most annoying in cold weather where the pipes are exposed. The pipe would be frozen and split or would not allow the water to pass through it, in case a sprinkler should be broken and not being discovered until it had thawed out and flooded the place. This, of course, could not happen if the alarm was in perfect order. But it is too often the case that a grounded contact will exhaust the battery, the diaphragm operating the switch is broken, the bolt in the lever has become so corroded that the lever cannot move, or the packing around the stem which passes through the case of the alarm valve is so old and hard that it can not be pulled out with a packing tool and for that reason it holds the spindle clamped tight as if in a vice, preventing the switch from being closed to give the alarm. Another mishap is from the wires connecting with the battery being broken by careless employes storing bars, shovels, brooms or other such tools around the large valves.

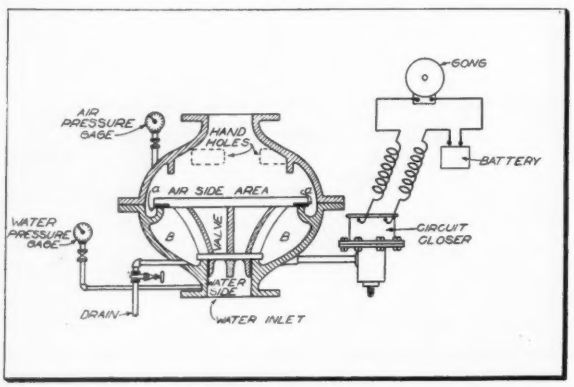


FIG. 1. OLD STYLE DRY VALVE WITH CIRCUIT CLOSER AND ALARM GONG ATTACHED

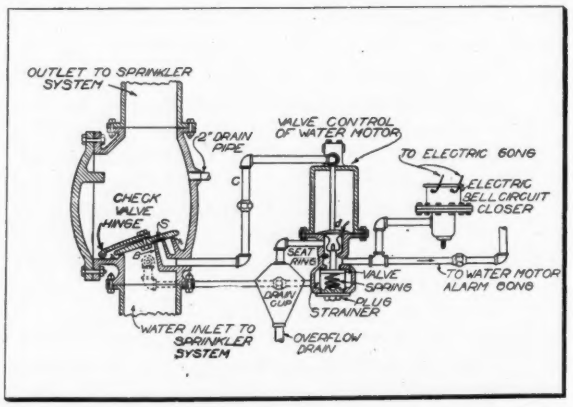


FIG. 2. CHECK AND ALARM VALVE WITH CIRCUIT CLOSER ON WET SPRINKLER SYSTEM

When a sprinkler head starts a very small air leak it is not easily detected, as the air can escape through such a small orifice without making a noise. It would leak for some time in this manner and could even have a slight hiss without being discovered, if there was any sound from running machinery in the room, not being discovered until the fuse became so badly sprung as to cause it to break and allow the air to escape and the water to rush through.

I had not been in one plant long before I discovered this perplexing problem and sought means of easy detection. The air pump valves will often leak, too, and allow the air pressure to drop from 85 lb. down to 45 or less during a single night, though the air pressure usually carried is about 30 or 45 lb., much below the water pressure; thus, the air pressure could drop quite low and still hold back the water on account of the large difference in the areas of the air side and water side of the valve discs, provided the gasket on the air disc was in good condition, or the air would leak through in between the discs and drive the water back through leaking valves of the fire pump. This poor gasket is generally the cause of the water getting through into the system, especially if there are any leaks around the handholes of the large valve case through which the air could escape.

This being my first plant using a dry pipe sprinkler system, I sought the advice of an engineer friend to learn, if possible, a way to discover small leaks.

"Well, you just give that air pump a dose of chloroform and that will put the leak to sleep so you can catch him napping easy."

As he paused to light his pipe, I thought of the old proverb of salting the fish's tail to catch it. Then the engineer continued to relate an experience of his own, when a dry pipe system had defied his diligent search for a leak for several weeks. He hit on the scheme of putting a substance into the air pump which would become a gas and mingle with the air, being carried with it through the system, and escaping through the vent, would create an odor of such a familiarity that the leak would be discovered in any room. This made the search for air leaks more effective; but the gases would accumulate in considerable quantity in the large valve chambers and cause some minutes' delay in allowing it to escape, when it was necessary to open up the case to examine the rubber gaskets or other parts of the valves.

Care must be taken in selecting the substance that is used lest it injure workmen in the room, or men searching for the leak be overcome with it. Some use a soapsuds cure; but this will mingle and dissolve in the water, if there is any water in the pipe, and become ineffective. Then, too, it requires much more time, as each inch of the pipe must be examined to discover the small soap bubbles as they ooze through the leak. Some use ether for this purpose; but almost any substance which will create a distinct odor would do the work and be less dangerous to handle than ether, chloroform or illuminating gas. In any case, it must be a substance

that will not be quenched by coming in contact with the water or cause excessive corrosion or pitting in the pipes.

Troubles come thick and fast with an old neglected dry pipe system, especially where it is difficult to get the required supplies for the upkeep of the plant.

Figure 1 is a sketch of a dry valve for a dry pipe sprinkler system. Its object is to keep the water out of the system until a sprinkler lets go, or a fire occurs to cause them to let go and release the air pressure, when the water will rush into the system. The air disc is about 8 in. above the water disc and about 6 times the area. An air pressure about 1/6 the water pressure is sufficient to hold back the water from the city main or fire pump.

The seat of the air discs is covered with a rubber gasket, a, a. This gasket will wear out or crack, allowing the air to leak through, putting an air pressure in the chamber B, B, between the valve discs, surrounding the connection of the 2 discs and guide. This air pressure under the larger disc equalizes the air pressure above and below it and makes it inactive and the air pressure, being only 20 to 25 lb. on the smaller area of the water disc, which has 100 lb. below it, will not hold the valve shut and the water will get into the system.

To detect this condition, a vent pipe was placed on the chamber B, B, to be opened to allow any air which had accumulated to escape, also to give warning of the leakage, as there is no air or water in the chamber if the valve is in perfect working order. It is with the gasket a, a, that most engineers experience trouble. If it is necessary to put in a new gasket and one is not handy, it must be made of gasket rubber. Care must be taken to have this gasket exactly the right thickness or it will hold the bottom or water disc up from its seat, allowing the water to enter the system. There are 2 pressure gages, one on the water side and one on the air side, so the correct ratios of pressure can be noticed at all times.

When a sprinkler head lets go, it is desired to have an alarm given, which is also a warning in case of fire. At the right of the sketch is shown a circuit closer, which is a small electric switch operated by the action of a metal diaphragm. Being raised by the pressure beneath, it forces the switch shut, closing the circuit, and causes an electric gong, which is connected to a storage battery, to ring. In many large factory plants, annunciators are connected to the same circuit in the office and engine room; it is known at a glance on which section of the system the sprinkler head let go or where to look for a fire.

The principal trouble experienced with the circuit closer is with the copper diaphragm, which, becoming broken, allows water to rise above it in the casing; coming in contact with the switch lever and clip contact, it closes the circuit, sounding an alarm, corroding the switch so it will not make a good contact, and the bell will not ring when a sprinkler lets go. This water, coming in contact with the switch, will also ground, exhaust and destroy the battery. The platinum contacts on the gong armature will become pitted, roughed, burnt and tarnished so the gong will not ring when the switch is closed.

For this reason, on many large systems it is customary to use a variable pressure chamber valve, in addition to the circuit closer and electric gong. The variable pressure valve admits water pressure to a water motor which will ring a gong, while the circuit closer operates the annunciator system; but this sort of valve is more commonly used on the wet pipe system, where no air is needed.

Figure 2 shows a cross-sectional view of the check valve used on the system and the variable pressure chamber with the circuit closer attached to the discharge pipe leading to the water motor. This device is also operated with a diaphragm, d, above the valve, e, indicating a hole in the diaphragm to drain out the upper chamber after the valve has closed. The plug at the bottom can be removed to clean out the screen or put in a new spring or to remove the main valve to face up the seat and disc in case they become grooved and leak. The top of the valve spindle is fitted into a valve disc, also a valve seat surrounds the spindle. When the pressure

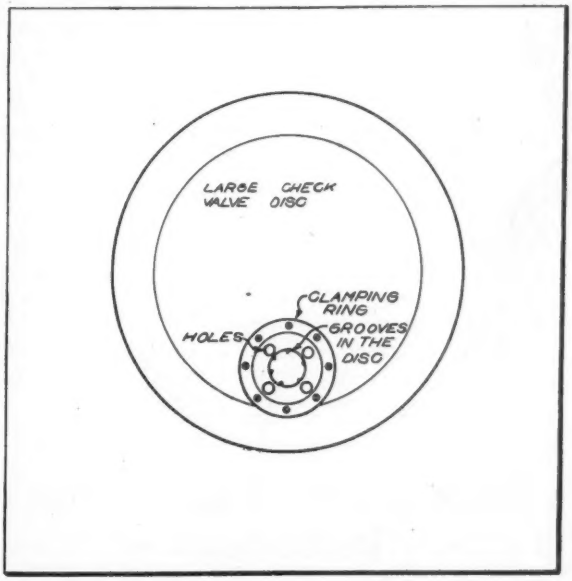


FIG. 3. FACE SIDE OF LARGE CHECK VALVE DISC

above the diaphragm forces the disc downward, it forces the main valve spindle downward, opening the main valve to admit water to the water motor, and circuit closer, at the same time closing the opening between the discharge chamber and the overflow chamber until the valve closes. But this main valve will not close until the check valve in the main supply line, at the left of the sketch, closes with the water pressure in the system.

This is where the writer had to do some thinking, and perhaps this may save some of the readers an equal amount of worry. There were no sketches or information to be had covering this type of valve, and the makers were long out of business. The valve had given much trouble from leakage, causing the gong to ring. The variable pressure valve was thoroughly overhauled, a new diaphragm put in and the valve discs both reseated on the seat rings; but there was still trouble.

The check valve was a most innocent looking affair from the outside; but who would suspect that it was a check and stop valve also? Concluding there was something in the shape of an automatic valve missing between the check valve and the top chamber of the variable pressure valve, I opened up the check valve and found that the check valve disc not only closed against its seat, h, h, but also had a small disc, s, attached to it to close the end, B, of the pipe. This small disc was badly grooved and the seat slightly cut, which was filed off slightly.

To repair the disc was no easy matter. It was made of 3/32-in. brass about 1½ in. in diameter, held in place by 8 screws through a clamping ring with ⅛-in. chamber beneath it and 4 3/16-in. holes through the disc to equalize the pressure on the back of it. The screws had all been heavily set in place by a center punch and could not be removed. After scraping all the grooves and the face of the disc bright, I took a soldering iron and put a deposit of solder on the face of this small disc, scraped it down to 1/32 in. above the surface and put the disc in the valve to get an imprint on the solder, which I continued to scrape off until I had a perfect fitting valve disc by the time I had scraped the solder down flush with the surface of the brass. If this had not been done, the deposit of solder would have held the disc off its seat, h, h.

The thin brass disc, Figure 3, was made thin to allow 1/64-in. spring, so when it closed over the point B, it would spring enough to overcome this slight difference and allow the main valve disc to seat at h, h. This removed the pressure above the diaphragm, d, in the variable pressure valve, which allowed the valve at the bottom of the chamber aided by the spring to close and stop the flow of the water to the water motor and the circuit closer. The valve now works nicely.

Recording or Non-Recording Instruments

FACTORS WHICH ENTER INTO THE SELECTION OF THE MOST DESIRABLE TYPE OF INSTRUMENT. BY J. C. HAWKINS

THE progressive engineer is sometimes at loss to decide whether the instruments he chooses for use in the power plant shall be of the recording, or nonrecording type. For instance, whether he shall choose the Orsat which, like the indicator, may be only occasionally used instead of a CO_2 recorder, and whether the extra cost of the latter will be warranted. It is true that fine recording instruments for various purposes are expensive, and their use may not be warranted in small plants, where they may be dispensed with in favor of the less expensive, and less desirable nonrecording type.

There are so many things that bear on the selection of the proper type of instruments that a decision is sometimes difficult. It is not necessary to use the engine indicator for valves very often, as the setting cannot be changed without the fact becoming known; but in the case of the flue gas it is different. A sample of gas taken covering a period of 12 or 24 hr. may be analyzed, and the average for that period of time determined; but that does not show up a set of firemen who may fire improperly for several hours at a time, nor could the cause of any low CO_2 be located unless a recorder was used which would show up the trouble at once. I am of the opinion that the extra cost of a CO_2 recorder over that of the Orsat will be saved in a plant of a few hundred horsepower in a short time by aiding the firemen in keeping a closer tab on the condition of the fires, and showing which of the firemen, if any, are not firing to the best advantage.

A common steam gage will show the pressure for the time being, but there is nothing about it to prove it by afterwards. In one case in which the writer was interested, a boiler plant had some trouble in keeping up the steam pressure, and for this reason many of the delays in the mill which were charged up against some department, were blamed on the power plant on account of low steam pressure. This was rightly denied by the engineer as being unjust, as the pressure was not always low when reported by the foremen. Therefore, unknown to either the engineer or mill superintendent, a recording steam gage was placed in the office and connected to the steam line. After a few days it became evident that the mill report of low steam was coming in whether the steam was low or not.

It is necessary to check up recording instruments occasionally for the reason that they have parts which may get out of adjustment, and they are in constant operation.

Each plant should have as many instruments of different kinds as possible to aid in securing information. The tendency, where nonrecording instruments such as the Orsat, steam flow meter, etc., are used, is to neglect them after the novelty of taking the samples or making the tests wears off, on account of the extra time required to operate them. An instance which shows the advantage of the recording type of steam meter was in a steam heating main to a distant building. It was known that the heating system used a great deal more steam than it should. The steam was reduced at the building from 125 lb. boiler pressure to 15 lb. for the system. After making a few changes in the system the pressure in the system was cut down to 7 lb. and later on to 2 lb., changes which saved, through the use of the steam meter, about 35 per cent of the steam formerly required to heat the building. Any instruments are good if properly used, and will help the engineer to get higher efficiency out of the plant; but the recording type is certainly a great improvement on the older nonrecording type.

TO PREVENT emery or any other abrasive material from falling into the cylinder of a gas engine while grinding in the valves, it is a good plan to tie a length of strong string to a small piece of waste and force the latter into the cylinder. If any of the mixture should happen to fall off the valve, it is immediately caught by the waste, and when the grinding operation is completed it may be easily drawn out with the waste by means of the string.—Gas Power.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Exciters and Excitation

METHOD OF EXCITATION; MAGNETIZATION AND VOLTAGE CHARACTERISTIC CURVES; EFFECT OF VOLTAGE CHARACTERISTIC ON OPERATION OF EXCITERS; CONNECTIONS. BY GORDON FOX

THE electromotive force produced by an alternator is caused by the movement of electrical conductors cutting lines of force emanating from magnetic poles of alternate polarity. These poles must be magnetized by an unidirectional current produced by rectifying commutators which change a portion of the alternating current to direct current, this being passed through the field coils for excitation, Another arrangement common in small units having stationary poles and revolving armatures provides a separate direct-current winding in the same slots with the alternator conductors. The alternating current is brought out through collector rings and the direct current through a small commutator on the opposite end of the armature, as depicted theoretically in Fig. 1. A serious disadvantage of this method lies in the fact that the armature reaction, the effect of load and lagging currents, directly affects the excitation through its action upon the field magnetism, with the result that inherent voltage regulation of such machines is poor.

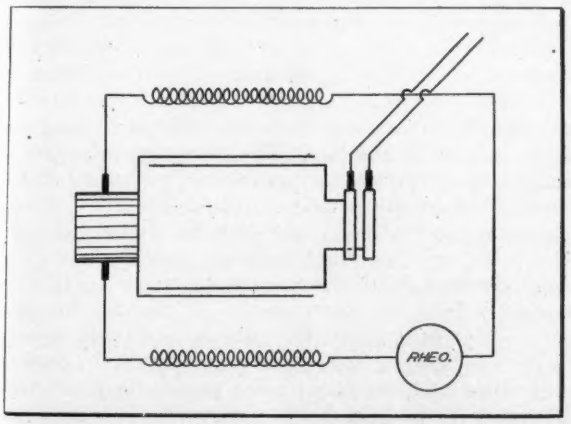


FIG. 1. SHOWING HOW A. C. IS BROUGHT OUT THROUGH COLLECTOR RINGS AND D. C. THROUGH COMMUTATOR

Magnetic lines of force of an alternator field pass through a circuit from an N pole across the air gap, past the stator conductors and through the teeth, through the stator core, past the teeth and again across the air gap to the S pole and into the pole piece and yoke. The magnetizing force necessary to maintain the desired flux in this circuit depends upon the length and cross-sectional areas of the separate parts and their magnetic characteristics. The total magnetizing force is the sum of the magnetizing forces required to set up the flux through the individual portions of the circuit. At low densities, the reluctance of the iron is small while that of the air gap is so great that it constitutes practically the total reluctance of the magnetic circuit. Since the permeability of air is a constant quantity the flux is proportional to the magnetizing force. When higher densities are reached, the reluctance of the iron becomes greater and the air gaps form a smaller proportion of the total reluctance. Since the permeability of iron decreases with increased density, the flux now increases less rapidly than the magnetizing force. At constant speed and no load, the voltage of an alternator is proportional to the field strength; hence the curve of voltage variation with changes of magnetizing current shows how the magnetic intensity increases. This curve, shown in Fig. 2, is called the magnetization curve. It will be seen that, where the influence of the air gap prevails, the curve is a straight line at low excitation;

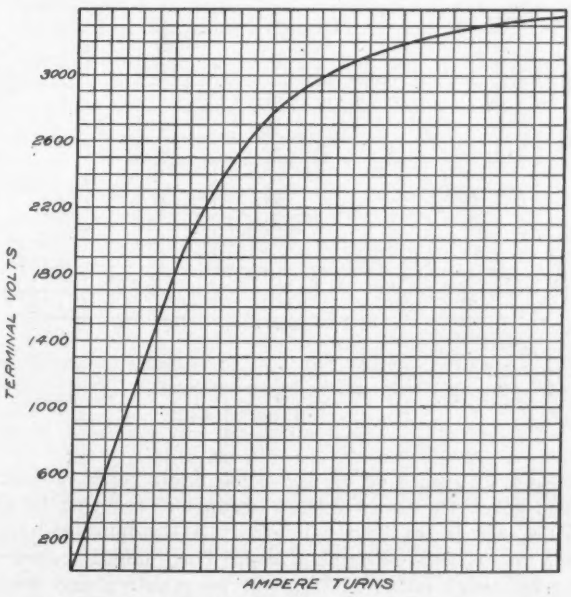


FIG. 2. MAGNETIZATION CURVE OF AN ALTERNATOR

but at higher densities, the effect of saturation of the iron predominates. With no loading on the alternator, the voltage varies as shown by the magnetization curve. When there are currents in the armature conductors, the magnetization is so affected that more field ampere turns are required than under no load conditions. The drop in voltage of an alternator under load is due to the resistance drop in the armature and leads, the armature reaction or demagnetizing effect and the increased magnetic leakage incident to heavy excitation. If the load upon an alternator is lagging, the armature currents have a direct demagnetizing influence; hence a heavy low-power-factor load requires the highest degree of field excitation to maintain the voltage. Stated in another manner, the demagnetizing effect of low-power-factor load causes the terminal voltage to drop off markedly, causing poor regulation. As a result, strong additional field excitation is required to compensate for this effect. Low power factor is ordinarily caused by numerous small or lightly-loaded motors on the feeder lines. Where service of this nature is to be given, liberal excitation capacity must be provided. Leading current assists or increases the field magnetism, while the effect of lagging current is opposite to that.

Nearly all excitation is at a rated voltage of 125,

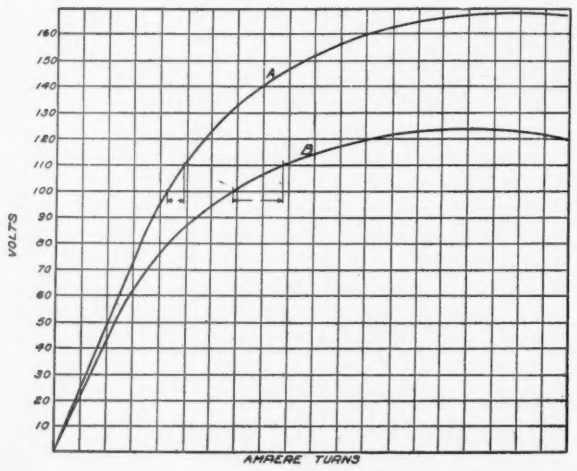


FIG. 3. SHOWING HOW THE VOLTAGE CHARACTERISTICS OF EXCITERS AFFECT THE FIELD CHANGES REQUIRED FOR CHANGE OF VOLTAGE

although in some of the large machines, 250 v. is used. The generator characteristics should be such that 60 to 70 v. across the field will give full alternator voltage at rated speed and without load. Then, under ordinary loads, about 90 to 110 v. will be required and with maximum load at 80 per cent power factor, the required field voltage should not exceed 125. The ratio of exciter capacity to alternator capacity varies according to the class of machines. High speed turbo alternators with few poles require comparatively small exciter capacity. Slow speed engine type machines having 60 to 72 poles require much more. The limits usually lie between 0.5 per cent and 2.5 per cent with 1.5 per cent as a fair general average.

Exciters should have characteristics specially adapting them to this service. Their magnetic circuits should be worked at a low point so that they will give full voltage at low excitation. Then a small change in the field current will cause a large change in exciter voltage. Exciters designed with saturated fields require large field changes for small voltage adjustments, hence the time interval or lag is great. This point is brought out in Fig. 3, which shows the voltage characteristics of 2 exciters. The magnetic circuit of exciter A is worked at low density, so that in the operating range a small increment in field current will cause a terminal voltage change of 10 v.; where the iron in exciter B is worked at a point well up on the curve, so that it requires a material increase in field current to cause a change of 10 v. Note in Fig. 3 the different field current increments corresponding to changes in terminal voltage from 100 to 110 v.

The value of low magnetic intensity in the fields is greater where automatic regulators are used since the exciter voltage will then follow more closely and more quickly the controlling action of the regulator. Low magnetic intensity in the exciter fields renders them more subject to the influence of armature reaction. A wide air gap is beneficial in reducing this effect. Liberal air gaps are, therefore, desirable in most exciters. If it is found that an exciter in service has its iron heavily worked and is sluggish in action, it would seem desirable to increase the rotational speed so that the machine may deliver rated voltage at a point lower on its curve. This will ease up on the excitation, will increase the ratio of armature to field magnetizing turns and may tend to cause sparking. If the field yoke is then slightly bored out, the effect of the armature magnetism is again reduced; the field current will return to about its original value, but the magnetic density will remain less than at the start and the performance may thus be improved.

Promptness in response is an important feature. Partly for this reason, the field poles of exciters are best made of laminations in order to reduce hysteresis lag. Compounding is desirable for exciters in order to compensate for voltage drop under load, and to increase stability in parallel running. The proportion of series to shunt-ampere turns at full load should not exceed 30 per cent. Exciters are usually adjusted for a flat voltage characteristic or for a 5 per cent rise under full load. Compound exciters provided with interpoles should be flat compound at 80 v., so that at 125 v. they will have a slightly drooping characteristic. If they are flat compounded at full voltage they will have a rising characteristic at lesser voltages, and when placed in parallel with other machines may tend to assume too much load. Rheostats for exciters should have a resistance of about 3 times the resistance of the shunt field circuit.

(To be continued.)

TO BURN names on brass, melt some white wax smoothly and evenly over a brass plate and let it harden. With a point needle trace the inscription on the wax, penetrating through to the brass. Apply strong nitric acid to the design, let stand 60 seconds or less, then wash off the wax.

Practical Experience in the Operation of Electrical Machinery

IMPERFECT SLIP RING CONTACTS; RESULTS OF CARELESS OILING. BY E. C. PARHAM

IT frequently has been observed that copper brushes when sufficiently burned, due to sparking, will become so much oxidized as to impair the conductivity of their contact surfaces, with the result that a generator on which such brushes are used may be unable to build up its field magnetism.

An effect similar to this was encountered in connection with a slip-ring induction motor used on a foundry crane. The motor was erratic in that sometimes it would start promptly and at other times it would not. Of the 3 motors used on the crane, the motor in question was the only one that gave this trouble. It would seem that this state of affairs might exist because the other motors were somewhat protected while this one was unprotected and was swung low where it was exposed to the dust and fumes from the molding floor. As the irregular action persisted even after the pinion had been drawn, the cause could not be attributed to parts other than those local to the motor itself. Upon establishing an independent stator circuit to the line and an independent rotor circuit through temporary resistances, it was found that the uncertain starting feature still existed.

It was while testing for balanced currents that the nature of the trouble was suggested. The stator circuits proved to be balanced under all conditions and the rotor circuits took equal currents at those times when the motor started promptly. At other times, one rotor circuit or another would take no current that was readable on the only ammeter that was available. In course of further testing of the rotor circuits with a voltmeter, it was found that, with the rotor blocked and the line voltage applied to the stator (which are the conditions under which the voltage generated in the rotor is at its maximum because the slip is 100 per cent) uniform voltages could be read across the slip-rings if the voltmeter test lines were applied to the sides of the rings. When, however, the test lines were applied to the bearing surfaces or to the brush shunts, the results obtained, if readable, were very uncertain. On using a magneto, it was equally uncertain as to whether its bell would ring upon applying the test points to any pair of slip-rings. The rotor was removed and the rings turned down. There was no evidence of burning on the rings, but in turning them down the machinist found it necessary to take off a full 1/32 in. in order to get under a skin that the lathe tool would not cut. This operation restored the normal characteristics of the motor.

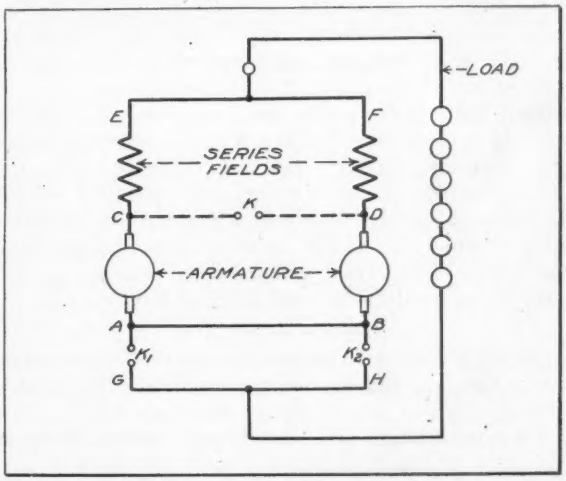
The crane man stated that the motor previously had sparked viciously on account of the rotor rubbing the stator, and that this condition had been aggravated by a loose brush-holder stud. It was after these faults had been corrected that the balky action had become most pronounced.

EQUALIZER ON THE WRONG SIDE

A PROPERLY connected equalizer between 2 compound-wound generators places their series windings in parallel.

If one machine is already connected to the load and the other machine is to be paralleled with it, the voltage of the incoming machine should be adjusted to no-load value after which the equalizer and the main switches should be closed in the order named, unless a special 3-pole switch is provided to close them simultaneously. In any event, the instant the equalizer switch is closed a part of the current from the loaded machine passes through the series field of the incoming machine, which increases the voltage of the latter by an amount that represents the voltage active in making it take its share of the total load. Furthermore, assuming that the machines are properly connected, the equalizer current insures that incoming machine will be of the right polarity and it also minimizes the chance of the machine being "motored" should its no-load voltage have been adjusted to too low a value.

An operator once complained that he could not parallel a new compound-wound generator with an older one "because there was something the matter with the new one." He further stated that there were fireworks each



EQUALIZER CONNECTION ON WRONG SIDE OF ARMATURE

time that he had tried to throw the machines together. An investigation disclosed that the operator, who had done his own installing, had connected the equalizer as indicated by the full line A-B. It should have been connected as indicated by the location of the dotted line C-D. In other words, the equalizer was connected on the side of the armature opposite to the series field, which resulted in simply increasing the capacity of the busbar G-H. Naturally, when the machines were paralleled there was no equalizing action and whichever one happened to have the lower voltage was run as a motor by the one of higher voltage.

If a properly connected equalizer is of sufficient cross-section to permit of its resistance being neglected and if the resistances of the series fields of the 2 machines are equal, the current from either loaded machine should divide equally between the series fields of the 2 generators as soon as the equalizer switches are closed.

Motor Throwing Oil

The tendency of motor bearings to throw oil, that is eventually drawn into the motor to saturate its windings, may be due to a hot bearing, or to a defective bearing, or to excessive and careless application of oil, or to the overflow pipe being stopped up, or to a pumping action that may become effective as the result of excessive lining wear. In most cases, however, excessive and careless oiling is responsible.

Except where information is furnished as to the amount of oil required to refill a bearing, or to renew normal loss, it is the better plan to apply the oil through the overflow pipe. By carefully noting the level of the oil in this pipe, while slowly pouring it in, a reliable indication of the oil level in the bearing becomes available. Most care takers resort to the quicker method of applying the oil through the top opening of the bearing. The objections to this method are that, unless the oiler is careful, he will spill oil outside or, if he is careful but continues to pour oil in until he sees a little run out of the overflow pipe, the overflow will continue for some time after the oiler leaves, since a certain amount of time is required for the oil to work its way down from above, and up through the overflow pipe.

An inspector was asked to prescribe for an elevator motor that was "throwing oil." The motor windings, brushes, brush rigging, slip-rings, floor and elevator platform were saturated and wherever oil could stand in pools it did. If the motor had been engaged in pumping oil, it could hardly have made a better showing. The inspector cleaned everything concerned with the motor, flushed out the bearings with gasoline, refilled the bearings through the overflow pipe until the oil came up to within ¼ in. of the top of the overflow, and then had a heart-to-heart talk with the oiler—which produced satisfactory results.—General Electric Review.

One Detroit-made automobile has the transmission case secured to the engine base-crank case by 12 stud bolts.

In assembling, a lock washer and nut are placed on each stud by hand. The nut is given one turn.

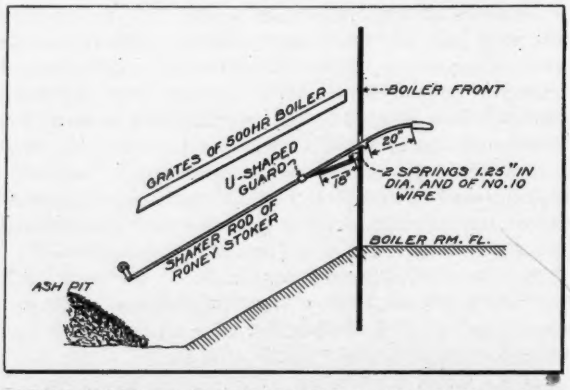
They are then turned very rapidly up to within approximately one-half of a turn of solid by a portable electric drill, in the chuck of which is a socket wrench. The operator judges when to stop, by noting the flattening of the lock washer. The final half turn is by hand wrench.

A saving of nearly 4 min. for each car results, which, on a thousand cars, amounts to about $200 a yr.—R. W. K., in Factory.

Pipes of asphalt-paper, a special German product, are replacing iron, steel, copper and clay pipes in Austria for conveying everything but hot fluids, concentrated acids and petroleum.—The Iron Age.

Saving the Muscles in the Fireman's Back

In the Washington St. power house of the Merchants' Heat & Light Co., Indianapolis, Ind., the most severe task of the firemen—that is, shaking the grates of the stokers—has been made comparatively easy, according to the Electrical World, which describes the device used. Twin springs 18 in. long and 1.25 in. in diameter, and made of No. 10 steel wire, have been placed on each shaker rod. When a fireman now releases the dog which holds the shaker rod in the "up" position the weight of the grates, aided by a slight push, sends the rod to its extreme "down" position and dumps the ash off the lower end of the grate. With the rod in this position the springs are at their point of maximum tension, and the rebound, aided by such a pull as can be exerted by a medium sized fireman standing flat-footed on the floor, returns the rod to its original position and latches the



SPRINGS ADDED TO SHAKER RODS IN AUTOMATIC STOKERS

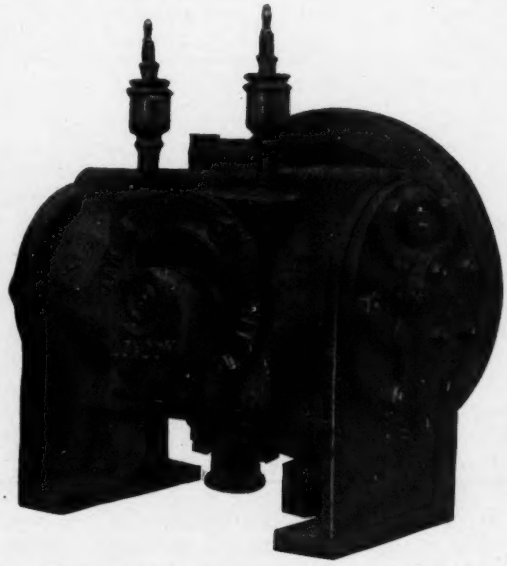
dog. In fact, the rods can be worked easily now that M. L. Addington, chief engineer for the company, in demonstrating the usefulness of the springs, easily returned one of these rods to its "up" position by using only one finger to exert the upward pull.

When a stoker is to be equipped with springs the shaker rods are removed and holes are drilled as shown at the lower end of the spring in the sketch herewith. A U-shaped piece of strap iron is then shaped and drilled so that it will slip over the shaker rod, and the holes in the strap iron coinciding with those in the rod allow this piece, when bolted in place, to serve as a guard to prevent the springs from becoming unhooked at the lower end. The distance between the upper and lower suspension points of the spring is made about 2 in. shorter than the over-all length of the spring, so that when the rod is in its "up" position the spring is compressed somewhat.

At a plant being constructed in Illinois, tailings from coal mines are to be substituted for clay in the manufacture of bricks. The process entails the combination of some coarse material, containing silica, with a binder of finely divided particles of silica, alumina, potassium, or sodium, in proper proportions. Bricks already made have withstood a temperature of 2900 deg. F. and a pressure of 20,000 lb. to the square inch, it is claimed.—Popular Mechanics.

An Interesting Type of Air Compressor

AN interesting type of compressing or exhausting air pump which has been designed with a view to minimize the space occupied by such apparatus and rendering the dismantling of the pump a matter of no difficulty and of little time, has been brought out by Messrs. Norman Dickson, Pringle & Co., of London. The chief point of the "En Dee" pump which is shown herewith is in the patent arrangement of valves and seats permitting the flow of air through the machine to be reversible. In this way an air compressor may be used as a vacuum pump and similarly a vacuum pump can be made to compress. The valves are of the disk type, normally kept on their seats by light steel springs. The 2 valve seats are formed one on either side of a gun metal block and conversion from compressor to vacuum pump is made by undoing the valve block and rotating it through 180 deg. in its socket, then tightening up the arrangement. A guard plate at the bottom of the valve seat socket prevents any possibility of the inlet valve or valve spring getting into the cylinder. The seats, blocks, valve, springs and guard plate are all secured in place by a flange and studs into the cylinder cover.



THE EN DEE AIR PUMP AND COMPRESSOR

The 2 pistons of the arrangement are cast in one, each being fitted with cast-iron rings, and one piston carries the gudgeon pin. The connecting rod is made in cast steel with adjustable large-end bushes and a long sleeve type small-end bush. A heavy flywheel is fixed on the crank shaft and an automatic unloading device allows the pump to run quite light when the desired pressure has been reached in the receiver, and restarts the pumping when the receiver pressure alters by a pound or so.

LEATHER WASHERS smeared with soap will not leak gasoline.

Natural Gas vs. Carelessness

BY NAT G. PUMPER

HAVING read several articles treating on air tank explosions, I thought an experience of mine might interest some of the gas engineer readers of Practical Engineer.

The tank in question was used by a large gas pumping plant to start their engines and was located outside the auxiliary room, was 60 in. diameter and 20 ft. long, tested to 200 lb., the compressor for charging was too small for the purpose and in an emergency a one-inch line from the high-pressure gas line was tapped in. The tank would be charged up to about 130 lb. and the engine started, then the tank would be blown clean and filled with air by the compressor.

RESULT OF AN EXPLOSION OF AN AIR TANK FILLED WITH GAS

This went very well for awhile, but one day the auxiliary engineer blew the tank down to atmospheric pressure, closed the outlet valve and proceeded to pump with air till he had 130 lb. gage and a beautiful mixture in that tank. A few hours later, another engine was to be started, everything was ready, the "air" was turned on, ignition switch pushed in and then one of the starting valves stuck open. That tank started 3 ways at once, the middle sheet straightened out flat and went about 4 ft. into the ground, cutting off a 10-in. line, one end started east, taking a 6-in. engine feed line with it and the other end went the other direction, landing in a bank of 16-in. gate valves which it demolished. A large farm house 120 yd. away was moved off its foundation and the plant was wrecked generally, and now they start with AIR.

TO GIVE brass a frosted appearance, which often makes a pleasing appearance on machinery parts, apply dilute sulphuric acid to which a little common salt has been added. The liquid should be dropped from a glass rod or a stick and should bring out the frosted appearance in from one to two minutes. To get the strength right, try a little first on a loose piece of brass, adding more water if it acts too quickly, or more salt and acid if the action is too slow. After the frosted appearance shows on the brass, rinse this quickly in clear water and dry it well.

Getting Experience

A Lesson in Ethics, Discovering a Trick. By John H. Armstrong

IN my last article I told you how I was out for experiences and was getting them in large doses. I will now give you an account of some more of my experiences. The chief ordered No. 1 boiler cut out and cleaned, and I was to report every repair that I thought necessary.

As the chief was gone when I finished, I wrote out a report like this: Back arch down, so that safety plug is inoperative. A square patch on first sheet over fire, which is single-riveted, and I figured the safe working pressure on the boiler at about 70 instead of 90. The blowoff pipe needs protection against the fire striking directly on it; and 5 tubes leaking in back head, on account of scale.

I hung this report on the bulletin board and went home. The superintendent got the report and showed it to the chief, and he came to the conclusion I had handed it to the superintendent.

When I reported for duty next morning I learned a few things on the ethics of engineering as applied between the operator and the man in charge, especially in regard to the duty of the operator to his chief, but the reverse application was not mentioned. He did not fire me,

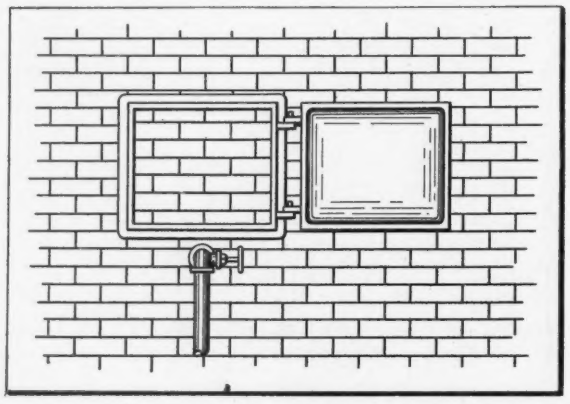


FIG. 1. JIM'S METHOD OF BRICKING UP CLEAN-OUT DOOR

but he said enough to make it evident that if I stayed I should have to bid good-bye to my self respect. So I asked for a bill of my time, and when he was a little dilatory about it, saying he wanted me to work out a week's notice or he would not pay me till the following week, I threatened to let the state inspector know the condition of his boilers if my pay was not forthcoming. I got it, and I hired out at another plant that same day, as chief engineer.

This new plant consisted of a 60-in. by 16-ft., horizontal, tubular boiler and Westinghouse Junior engine, and a third-class license covered it. This was at a shirt shop and laundry. Washing day was every Monday, and the Westinghouse ran the machinery and heated up the wash water and drying room with the exhaust on washing day. On other days the exhaust went free. The engineer had to do the washing and extracting, keep all the belts in repair, also the machinery, except the sewing machines.

My predecessor consented to stay with me that first washing day. His name was Jim, and he was a good, all-around engineer, machinist and good fellow.

Say, did you ever take a job where everybody regretted that your predecessor had gone and considered you an interloper for taking his place? Jim was leaving because the firm could not see its way to pay the increase in pay that he demanded, but everybody, including the boss, was sorry that he left.

Everything that Jim had charge of was clean and in good repair. The boiler seemed to steam hard for the work she had to do. I looked her over for cracks in the setting, but found none. I thought I had the cause when I found the combustion-chamber door not properly closed, but upon examination I found the hole bricked up, as in Fig. 1. I learned something then, and if ever I take charge of another plant, the clean-out doorway

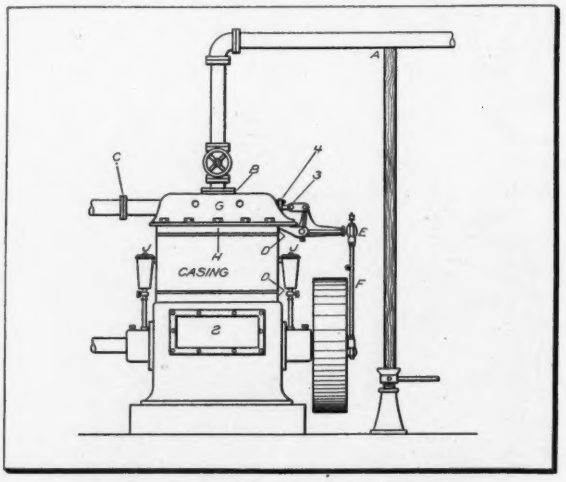


FIG. 2. WESTINGHOUSE JUNIOR ENGINE

shall be bricked up. It takes only 15 fire-bricks and a pail of mortar to make a tight job, and the bricks will last for 20 yr. if one is careful in opening up. It is worth the time spent upon it, for an air leak costs money.

The engineer had to give a report every night, of the amount of coal, water, oil, starch, soap and washing powder used during the day.

I thought I was getting along well for a greenhorn, until the boss came to me with a bunch of reports that showed I had nothing on Jim as a fireman, for I burned more coal by 300 lb. on Tuesday, and an increasing amount every day, until on Friday I burned about 700 lb. more than had been burned before.

I was given another week to do better. If I did not improve, they were going to send for Jim, and give him

his increase he had asked for. I opened up the boiler on Sunday and found it as clean as it could be; looked over the piping; tried the blowoff for leaks, and found everything O.K.

Then, I asked myself, "What do you know about a Westinghouse engine?" I had to confess that I knew nothing.

I thought of writing to the company, but I could not get an answer in time. I thought of asking Practical Engineer to help me, but the time was too short. I hated to get bounced for incompetence, and as I was thinking about it, it came to me like a flash, that in the power station close by there were some Westinghouse men, overhauling a big turbine, and perhaps they could help me. I went over and found them, and after telling my story, they were ready to help me all they could, but they could not leave the present job before Monday. One of them made me a sketch, Fig. 2, and told me, if the piston rings were leaking the vapor pipe would show

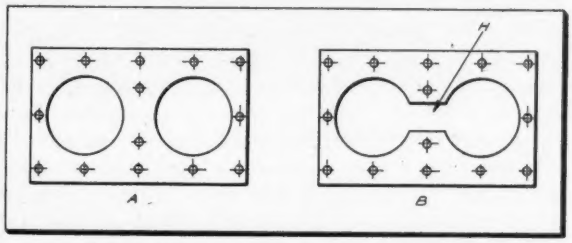


FIG. 3. PACKING PROPERLY AND IMPROPERLY CUT.

it, and if the valve was leaking, the exhaust would show it. He thought that the packing had blown out between the 2 cylinders.

I went back, started her up; the vapor pipe showed nothing but vapor, but the exhaust was a continuous stream. I got out the sketch and instructions and studied them over, then went at it. Perhaps there are some engineers that know all about it, but I didn't, and there are a good many others that do not.

I pulled her apart, according to instructions, got a prop and jackscrew, put under the pipe at A, removed the bolts at B, screwed up jack until joint at B was broken, broke joint at C and under E and let down F on the floor out of the way, took off oil cups JJ, removed the screws from straps DD. (One has to be careful in removing the straps, as they are liable to fly out and strike you.) Then all the drip pipes were removed (not shown in sketch), then the casing and wood lining, then the bolts holding the valve chest to the cylinders, not forgetting the two at H, that screw in from the under side. Then one man took hold of the pipe at C, the other at E, or the rocker arm, turned the valve chest at right angles to the cylinder, slid it along and lifted it on to the wheel, thence to the floor. Two men can do this, but 3 can do it better.

Then, to remove the pistons, we had to take cover 2 off and remove crank bolt and take out shims, letting the bottom half of the crank box swing back, turn the flywheel until the piston came to the top of cylinders, get an I-bolt, climb on top of cylinders and lift out the piston. To take out valve, remove link 3, let down rocker out of the way, take off cap 4 without disturbing the stuffing box, then pull the valve out.

I got the watchman to help me do the job, and found everything O.K. except the packing, which was broken between the cylinders, as the Westinghouse man had said he thought was the trouble. I removed the packing, which was quite new, cleaned off the surface, got a sheet of thinner packing and put it over the top of the cylinders and marked it out with a pene hammer, then cut it. It was as shown in Fig. 3A. The watchman then told me I had forgot to cut out the piece between the holes, as at H, Fig. 3B.

I said, "It doesn't need it"; but he came back with, "Yes, it does. Jim should know, and I saw him cut it like that when I helped him do this same job the Saturday night before he left here."

The cat was out of the bag now, and I knew who had caused me all this work. I said nothing, but we lifted the valve chest on, blocked it up, and with the aid of 2 sheets of tin, inserted the packing, put her all together, started her up, and as everything was all right and it was nearly starting time Monday morning, I cleaned my fire and tubes, then started her up.

At noon the boss told me I had better go over to the brewery, where Jim was working, and get a few pointers from him. I did, and took the old gasket with me.

When I broke the news to Jim, he laughed, and said, "Well, you found it. I thought you were too green to find out the trouble, and that you would burn so much coal the boss would fire you and I could have the job back at my price."

"So, Jim," I answered back, "you were just thinking about that raise in pay when you played your little trick. You never thought about my reputation, and that if I had been fired I should lose it." He said, "Gee, I never thought a third-class engineer had any to lose."

I have been here 6 months now and the boss likes me fairly well, but Jim is still his ideal engineer, although I have received Jim's raise when I asked for it.

I am often tempted, when the boss is praising Jim to me, to show him that gasket and turn his idol into clay before his eyes, but—what's the use?

U. S. CIVIL SERVICE COMMISSION announces the postponement from May 12 and 13, 1915, to June 23 and 24, 1915, of the open competitive examination for marine engine draftsman for submarines, to fill a vacancy in the office of the Inspector of Machinery, Electric Boat Co., Groton, Conn., at a salary of $5.04 a day, and other vacancies. The following subjects will have the relative weights indicated: Mathematics, 15; materials, details and specifications, 20; drawing and design, 25; education, training, and experience, 40. Applicants must have had an education of at least 2 yr. in engineering in a reputable technical school, and at least 2 yr. drafting experience; or 4 yr. suitable practical experience, of which at least 1 yr. must have been employed in office drafting. Experience in the design or construction of submarine machinery is necessary for eligibility. Apply for Form 1312, giving the title, Marine Engine Draftsman for Submarines (Male).

GAS POWER APPARATUS

Producers, Engines and Industrial Applications

Gas Power Station at Valparaiso

MODERN PLANT IN SOUTH AMERICAN CITY WITH SPECIAL SUCTION PRODUCERS AND DOUBLE CYLINDER ENGINES. BY J. C. VAN LANGENDONCK

IN anticipation of the opening and development of the Pacific ports in Central and South America, made possible by the Panama Canal, Valparaiso has had in progress, for some time past, large extensions and improvements to its harbor. These improvements require quantities of granite to be quarried, a great number of concrete blocks to be made and, as the work necessitated the use of dredges, cranes, locomotiyes, etc., the provision of a completely equipped repair shop. For carrying out the work, the contractors opened extensive quarries at Salinas, about 4 mi. across the bay from Valparaiso, and here they have installed the block-making establishment and repair shops and have also constructed a large pier for the shipment of stone, blocks, etc., at Valparaiso.

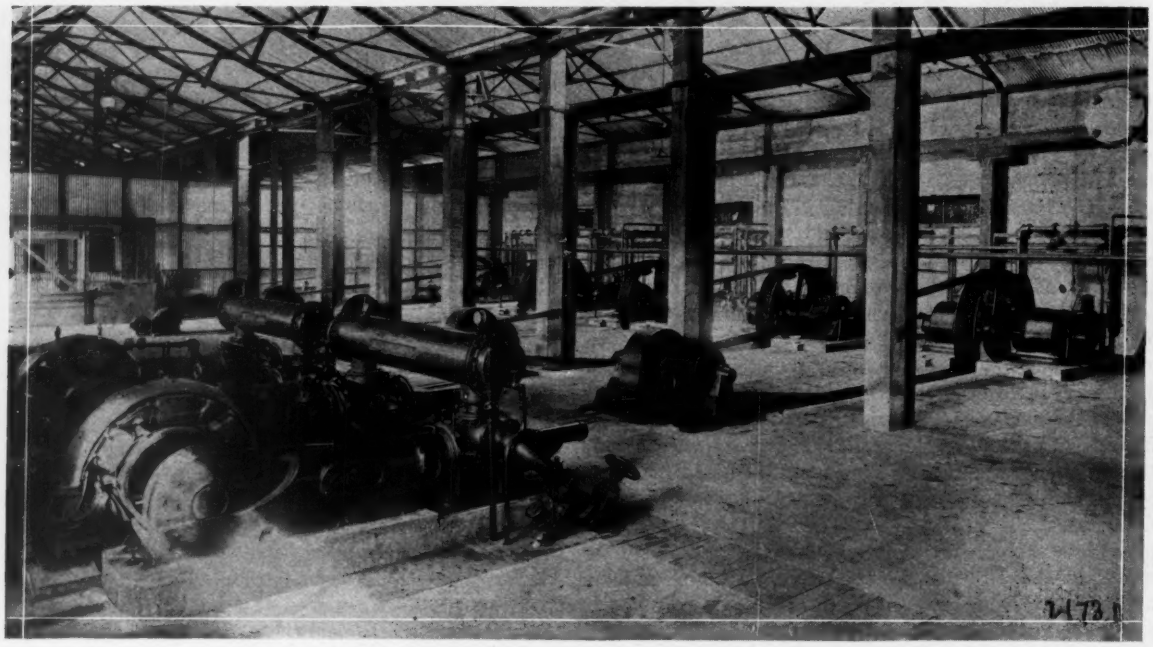


FIG. 2. ENGINE AND COMPRESSOR ROOM

Power utilized in the Salinas shops and yards is generated in a suction gas producer station located at this place, the current produced being used to compress air for the stone drills, in block making, operating stone crushing machinery, working yard cranes, loading cranes on the jetty, operating machine tools in the repair shops and also for lighting.

STATION EQUIPMENT

THE GENERATING plant illustrated in Figs. 1 and 2, was supplied by Ruston, Proctor & Co., Limited, and consists of 5 double-cylinder suction gas engines, each rated at 152 b.hp. Five producers of the Ruston standard make and using anthracite coal are so arranged that any one of them may be shut down and the corresponding engine supplied from the next producer. Special features claimed for them by the makers are the large sized hopper and fuel chamber, water sealed ash box, special poking holes, 3-way valve for shutting off scrubber feed water heater to vaporizer, and multiple gas outlets to generator to insure equal distribution of air and steam through the incandescent zone and thereby prevent local heating. To reduce the amount of labor

in connection with the starting of the generator, the usual hand fans are dispensed with and instead 2 engine-driven fans are employed. The engines driving these

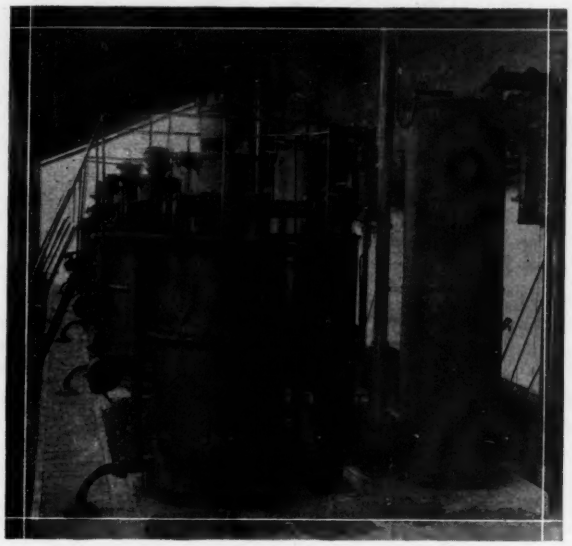


FIG. 1. PRODUCER ROOM OF VALPARAISO PLANT

fans also supply power to the air compressors in connection with the self starters for the engines.

Each engine has 2 bed plates and 2 cylinders with the flywheel placed between, which was made specially heavy to secure good regulation. Double-cylinder engines were chosen in preference to a large single-cylinder on account of steadier operation and also for economy's sake, as it is possible to operate on but a single cylinder on light load. For a given horsepower, double-cylinder engines are easier to transport and erect on account of the lighter weights of the main parts, an important feature in machinery sent abroad.

Governing of these engines is accomplished by the Ruston variable admission gear, one governor controlling the admission of gas and air to both cylinders according to the load on the engine.

The main bearings, the outer bearings, and the cam shaft bearings are fitted with ring oilers while the cylinders, pistons and exhaust valve spindles are lubricated by special patented multifeed force pumps, the cylinders receiving their oil supply at 3 different points.

Compressed air supplied by a 2 to 2½-b.hp. petrol engine and stored in 2 steel reservoirs, is used to start the engines, which is accomplished automatically by means of a cam on the side shaft actuating the starting valve at the right moment.

The generators, which are rope-driven, were supplied by Dick, Kerr & Co., Limited.

Two Ingersoll-Rand compressors, each driven by a 151-hp., 500-v., General Electric, direct-current motor at 225 r.p.m. and having a low-pressure cylinder of 17¼ in. and a high-pressure cylinder of 10¼-in. diameter by 16-in. stroke, supply the necessary air for use about the shop and yards.

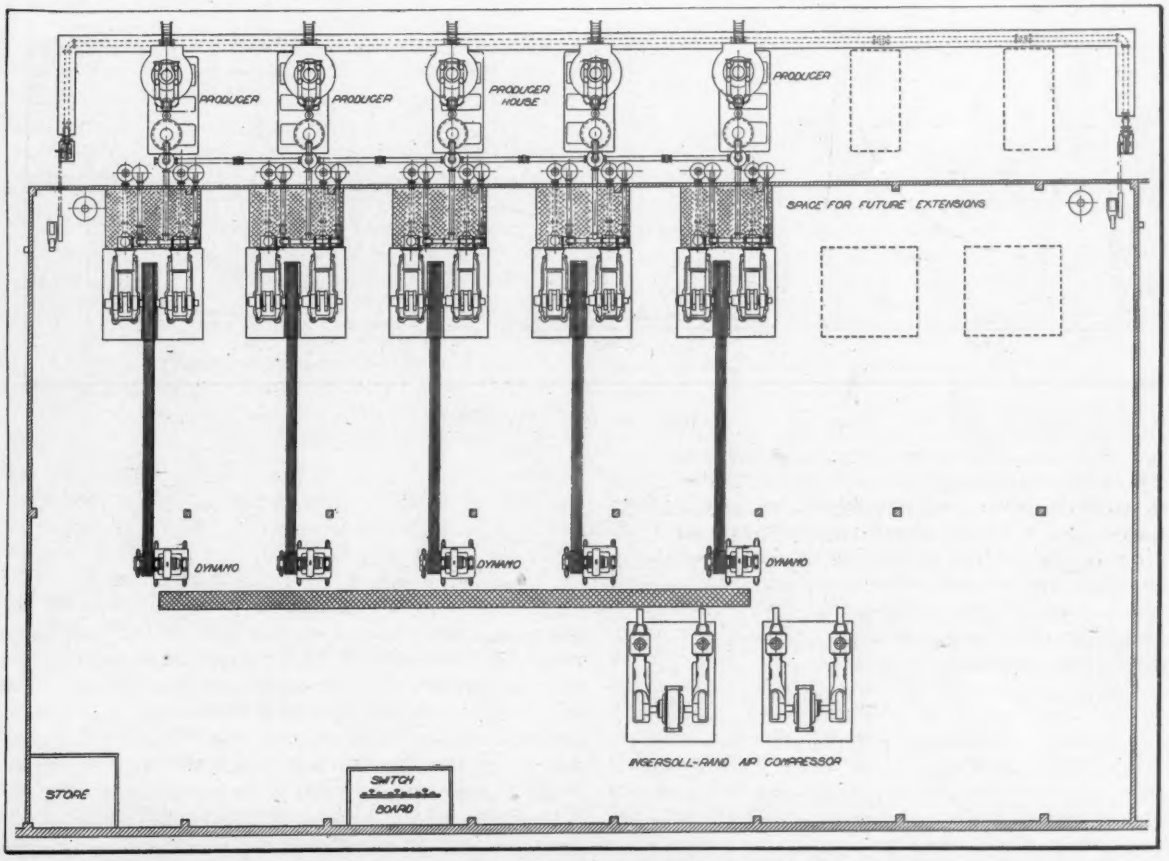


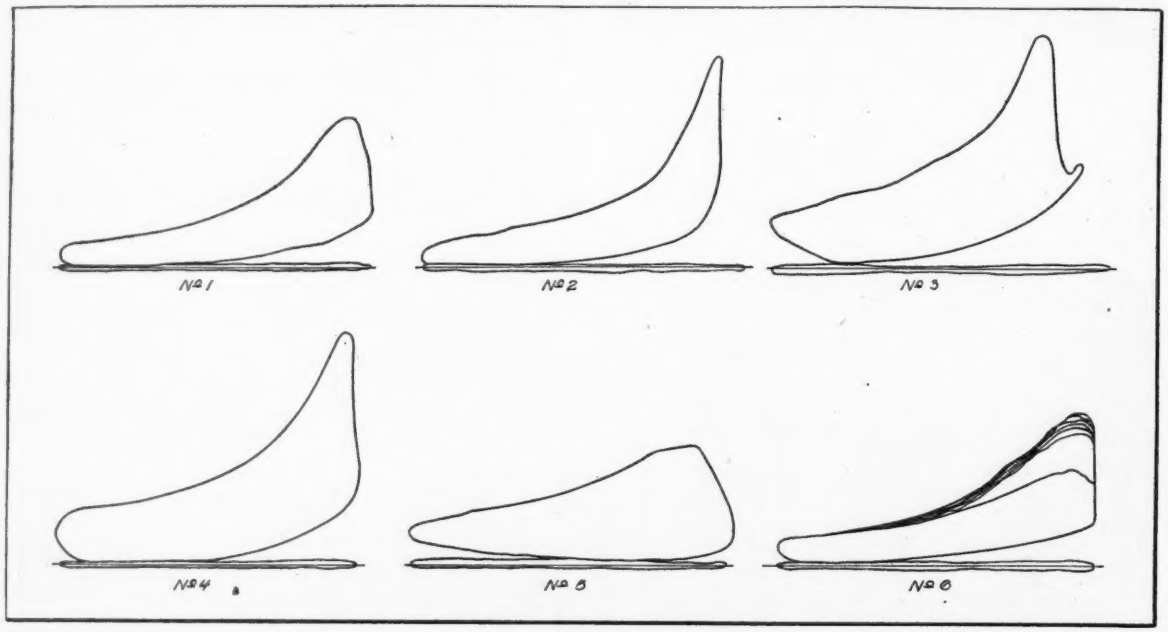
FIG. 3. PLAN OF VALPARAISO GAS PRODUCER PLANT

Some Indicator Cards From a Gas Engine

By George W. Muench

INDICATOR cards are always of value and are the real trouble finders. The indicator is being used more on the gas engine, as the operators are getting wise to the fact that it is the real way of finding all the little troubles that otherwise would not be noticed. Poor compression, late or early ignition, improper valve timing, improper mixture, back pressure are all clearly shown on the indicator card. The following cards are all interesting and were taken on a 7.5-hp. hit and miss engine and clearly show a few of the common gas engine troubles.

Number 1 shows that the engine was getting a slow burning mixture. The time of ignition was correct, but too much time was consumed to reach maximum pressure. Number 2 shows a card taken after correcting the mixture without changing the time of ignition. Number 3 shows that the ignition was coming entirely too late, after the piston had already started on the power stroke. Also, the card shows improper exhaust valve setting, the exhaust valve opening too late. Number 4 shows the results after correcting both troubles, and gives a much different appearing card. Number 5 shows a very poor compression as well as a slow burning mixture, undoubtedly partially due to the weak compression causing slow burning. The card also shows back pressure during the exhaust stroke. Number 6 shows 7 complete expansion strokes. The first card has a low explosive pressure, all the others being decidedly better. This is very common with a hit and miss engine, the first explosion being weak due to the presence of too much exhaust gas.



TYPICAL GAS ENGINE CARDS

Speed Limits of Internal Combustion Engines

Wire Drawing and Weight of Valve Gearing Determining Factors

AT ordinary speeds, the work done by internal combustion engines is directly proportional to the speed. This is due to the fact that the work per cycle is practically constant and that, as the speed increases, the number of cycles increases. It is not possible, however, to increase the power indefinitely by increasing the speed, for, as the speed of the engine increases, the effect of wire drawing in reducing the quantity of the charge taken in per cycle, also increases. When the engine is equipped with mechanically operated valves and is running at speeds below 400 or 500 r.p.m., this effect is scarcely noticeable, but at speeds greater than this, the net work per cycle, on account of the wire drawing, gradually falls off.

The speed at which the power of an internal combustion engine reaches its maximum depends upon the size and construction of its valves and ports; the larger and straighter the gas passages, the higher the speed at which the maximum power is developed. With ports of the usual proportions, it is found that small 2-cycle engines deliver their maximum power at from 700 to 900 r.p.m., while 4-cycle engines deliver their maximum power at from 1200 to 1800 r.p.m. At higher speeds, the quantity of charge taken per stroke decreases at a faster rate than the speed increases, and as a consequence the power of the engine falls off. At still higher speeds, ignition fails from lack of sufficient compression of the charge, and the speed of the engine finally reaches a maximum at which the power developed is just sufficient to overcome the friction of the parts.

In general, the speed of large engines is much lower than that of automobile and other light high-speed engines, the usual speed of units of 1000 hp. and over varying from 75 to 150 r.p.m. In the case of single-acting stationary engines, however, the speed is usually from 200 to 300 r.p.m., with a tendency toward even higher values. As a usual thing, the speed of a large gas engine is limited by the highest speed at which the valve motion will work quietly and without undue wear, and it will thus be seen that the speed is really limited by the design of the parts, and will of necessity be lower for a large engine with heavy parts than for a small engine having light parts.

Balky Gas Engine

AN OBSTINATE CASE EASILY REMEDIED. BY M. E. GRIFFIN

RECENTLY a small gas engine was installed which, after being started, would run for a few minutes and then, for no apparent reason, would stop. After this happened several times, the engineer in charge gave it up as a bad job and the writer was called upon to find if possible the cause of the balking and remedy it.

The engine was of the valveless type with trunk piston and splash oiling system. Upon examining the gas used, it was found to be comparatively clean and of a good quality. All machine work on the engine was good and working parts were of an easy running fit. The piston fitted the cylinder apparently well, as did also the piston rings, of which there were 4 of the spring ring type.

After 2 or 3 attempts to make it run, it occurred to the writer that, as the piston was not water jacketed and explosion took place at one end of the cylinder only, the end of the piston became heated to such a temperature that it expanded and became stuck in the water cooled cylinder barrel. After removing the piston and grinding it a slight taper toward the head end, it was found that the engine ran much longer and, therefore, it was finally ground so that its crank end had 1/128 in. clearance (on diameter) and its head end 1/16 in. clearance. This caused the engine to run without a hitch.

Trunk pistons for valveless crude oil engines should have liberal cylinder clearance, but do not require as much as gas engines, due to the fact that the water fed to the oil engine cylinders keeps the temperature within reasonable limits. In this connection, it should be borne in mind that with oil engines the piston rings should have liberal side clearance in their grooves because of the carbon deposits which otherwise sometimes cement the rings solid in their grooves. In fact, many cases are known of, in marine practice, where rings were so solidly cemented in the grooves that they had to be chipped out piecemeal.

A GOOD practice in foundries, where burns are frequent, is to put on thick soap suds. The lather keeps out the air and draws out the inflammation. After a few minutes the burn, if a bad one, may be wrapped up, but if just an ordinary burn, an occasional application of lather is all that is needed.

New Fuels for German Automobiles

ON March 15, in accordance with a recent order of the Bundesrat, about 25,000 automobiles ceased operating in and about Berlin. This step has been taken to conserve the supply of benzine,* benzol, and rubber.

Many German technical men are of the opinion that in a very short time a great variety of fuels will be used in automobile engines—fuels that up to the present have been used only for stationary explosion engines. They believe that conditions brought about by the war will result in discarding the more expensive motor fuels, especially benzine.

It is stated by the same authorities that pure benzine has not been used for years, having been superseded by a fuel originally known as "mononaphta," in which the pure benzine is mixed with other oils. This mixture has come to be known as "benzine," "automobile benzine," or "heavy benzine." Motors have been adapted to this heavy fuel. Benzine would have been replaced long ago by benzol, which is a coal-tar product, if the manufacturers of benzol had not bound themselves by deliveries to foreign countries. Many automobile owners, however, still believe that the use of benzol is harmful to their machines.

Much interest has been taken in the subject of mixing the materials now available in reasonably large quantities. The use of pure petroleum or pure alcohol is not considered, as the supply of neither can be considered unlimited. Regarding the use of mixtures, the following information has been obtained:

Benzine and benzol can be mixed with petroleum as well as with alcohol, and 4 different homogenous fuels can be produced by such mixing, namely, (1) benzine-petrol, (2) benzine-spirit, (3) benzol-petrol, and (4) benzol-spirit. As benzine and benzol may also be mixed, the 4 mixtures mentioned may also be mixed—(1) with (3) or (2) with (4). In this way fuels can be obtained that are composed of 3 of the original fuels—benzine-benzol-petrol and benzol-benzine-alcohol. These 2 liquids, as well as the 4 first named, are perfectly homogenous.

Tests have been made with the mixtures of benzine and petroleum, and it was found that no changes in the ordinary motor was required. When alcohol was added, however, a perforated lead disk was attached to the float, and an especially effective warming mechanism was attached. The benzine-petrol-spirit can be used up to the last drop, with the motor always working well. Mixtures of half benzol and half alcohol and of 1/4 benzol and 3/4 alcohol have been tested with less satisfactory results, although with some changes, including the elimination of the ventilator, real progress is being made.

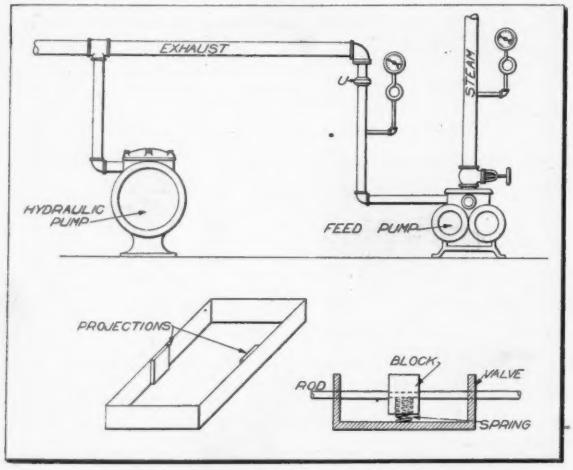
*In this report the word "benzine" is used in the continental manner and refers to the motor fuel known everywhere in the United States as "gasoline." When referring to motor fuel, the "benzine" of the Continent, the "petrol" of Great Britain, and the "gasoline" of the United States are synonymous for the same petroleum distillate.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Unusual Pump Trouble

I AM in charge of a small plant which I installed. We have the usual assortment of pumps, and at the time of installation I was forced to connect the exhaust from a large hydraulic pressure pump, and the boiler feed pump together, both to discharge from one head. I recommended that valves be installed in the exhaust line between the machines, but my recommendation was overruled by our superintendent. I am forced to admit that I did not give the matter much thought after this, as I did not anticipate any trouble from this source aside from the inconvenience of working on a pump that was down for repairs when the other was in service. As a direct result, I overlooked a point that was to give me a great deal of worry.



TROUBLESOME CONNECTION AND PUMP PARTS

One day my curiosity was excited by watching my fireman's method of starting the boiler feed pump; this consisted of hammering on the end of the valve rod links, with the throttle wide open. Inquiry disclosed the fact that for a week or more, the boiler feed pump had refused to start without being coaxed with a hammer or wrench.

I had been busy installing a new drive on a calender, and the day man gave this as the excuse for not letting me know about the pump. The night man, however, claimed he had no cause to report the pump, as it went along all right with him. Investigation proved this to be true, so I laid the trouble to carelessness in looking after the lubrication, but without mentioning my suspicion, I kept an eye on the lubricators for the next few days. To my surprise I found the fireman had speeded up the lubricator on the feed pump.

Of course, I now saw that there was really something wrong.

First, I attached gages to the suction and discharge lines. Everything seemed O. K. here; then I pulled the water end apart, trued up the valves and seats, repacked the plungers and rod boxes, still with no result. Next, I blanked off the union (U), and tackled the steam end of the pump, cylinders in fine shape, well lubricated, and as smooth as glass, rings tight, and valves and seats seemed all right. Out came the valve rods and piston rods, and they were tested on the lathe for straightness. All in all the pump seemed in fine shape, and yet with 100 lb. pressure in the steam chest, the pump would not start. I found that the pump would run fine if exhausting on a line by itself, but this did not explain why it would not work well on the line with the other pump. All this pulling apart and putting together had taken the best part of a week, and as we needed this pump badly, I was getting worried. As is usual, a number of my engineering friends had dropped in and each had made his guess as to the probable cause of my trouble, but none of them was right.

I had made my mind up that the trouble was in the exhaust, but just how and why I couldn't for the life of me find out, and it was not until I got wit enough to put pressure gages on the steam and exhaust lines that I saw the light. With the gages located as shown, and the steam valve (throttle) wide open, the pressure would almost equalize in the steam and exhaust pipe. Then as soon as the pump (assisted with a hammer), would start, the pressure in the exhaust pipe would drop to normal (about 5 lb.).

I was not long in finding the cause of this unusual condition. This pump has, on the inside of the valve chest, projections which keep the valve from lifting from its seat. Now when the hydraulic pump started (about every 5 min.), with the feed pump out of service, the exhaust from the hydraulic pump would cause the steam valves in the feed pump gradually to play up and down. In time, this movement caused the projections on the inside of the chest to wear away until the lift of the valve became great enough to allow the live steam from the throttle to hold the valve from its seat.

As a remedy I bored a ½-in. hole in the lost motion pieces, and inserted a spring in each hole. Springs had tension enough to overcome the exhaust pressure from the hydraulic pump. The springs rest on the back of the valve, but are not tight enough to prevent the pump from getting its proper amount of lost motion.

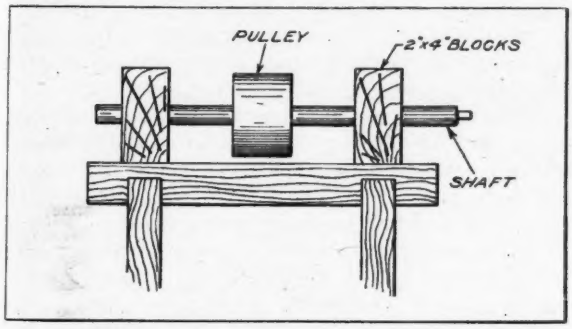
I expect to have to renew these springs from time to time, as no doubt the hot steam will draw the temper; but this renewal will be an easy matter and is not worth considering. ARTHUR D. PALMER.

Adjusting Speed of Commutator Slotter

AFTER TURNING down the commutator on a 250-kw. motor generating set, we decided to slot the mica out a little as precaution against sparking.

The company had a slotting machine at one of its other plants which was sent for. This machine was motor-driven at about 250 or 300 r.p.m. We were informed by 'phone that we would have to have our own motor.

Nobody at the plant where the work was being done knew anything about the machine or how fast it should run, so when we had a ¼-hp. motor running at 1800 r.p.m. we thought it would be all right. When the machine came and was started up, it ran much too fast and vibrated so badly that it could hardly be held. It was seen that the machine could not be used at that speed and we had no motor of less speed, so we finally decided to make a shaft with a pulley in the center, which was to be belt-driven by a ½-hp. motor, running



JACK SHAFT FOR COMMUTATOR SLOTTER

at 1800 r.p.m., and was made in the following way: Two pieces of 2 by 4 lumber were got and a hole 1¼ in. in diameter was drilled in each block. Next, a piece of wrought iron was turned down to the same size as the holes. As we had a 6-in. pulley with the same size hole in it as the shaft, it was slipped on and held in place and from turning by a set-screw on each side of the pulley. The blocks were then nailed down to 2 wooden horses, and the end of the shaft slipped into each block, which acted as a bearing. The horses were nailed together to prevent them from working apart or getting out of line. As the motor shaft was only ½ in. in diameter, some tape was wrapped around it in the opposite way from the way the motor ran to make a small pulley. This was made about ¾ in. in diameter. The motor was put on the floor between the horses, the belt was put on and the motor and shaft were started. It ran well and gave us a speed of about 225 r.p.m. This was a good speed and a satisfactory job was done.

R. G. CURREN, JR.

Piston Clearance

I KNOW by experience that there should be big difference in the clearance now in vogue. I suppose the man who asks the question in the April 1 issue is thinking of a stationary engine. Of course, equal clearance is all right, but how much clearance? On a locomotive, it makes a difference which end has more clearance, as the main rod is connected to the wheel, and if the wheel, on account of the unevenness of the track, and for instance if the wheel happened to go off the track at the time the piston is on the dead center back end, it would knock out a cylinder head.

If I were going to build a thousand locomotives I would give them 1 in. clearance on each end of the pistons. I know from actual experience that this is right.

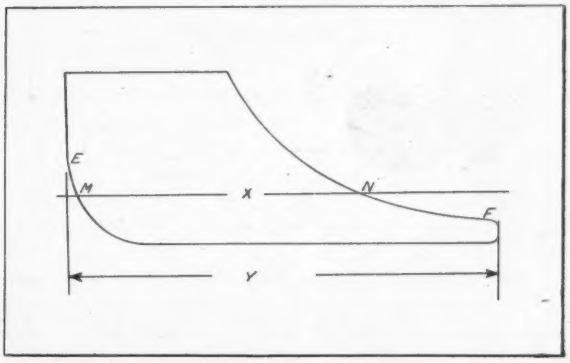
H. E. CHURCH.

Steam Consumption from Indicator Diagram

IN REGARD to finding the steam consumption per horsepower-hour from the indicator diagram, the method given in the March 15 issue, 1915, is correct, except for the method of finding the clearance line, the proper procedure being given in a correction note in the following issue.

Fortunately, there is a shorter method of finding the steam consumption; a method in which the clearance volume need not be taken into account at all. Whenever the compression, as shown on the diagram, reaches a point higher than the point of release, the following method will be preferable. It is not only shorter, but it does away with the error which is always probable in locating the clearance line by means of points on the expansion curve.

In the figure, the line X is drawn at any convenient height above and parallel to the back pressure line, only so that it is below the point of admission E and above the point of release F. For saturated steam, such a line



DIMENSIONS REQUIRED IN CALCULATING STEAM CONSUMPTION

is a line of constant volume. A pound of steam at the point M has the same volume as a pound of steam at the point N. It will be evident at once that the volume of steam exhausted per stroke will be represented by the distance MN. This volume is less than the volume swept through by the piston. Dividing the length of MN or X by the length of the diagram, gives the part of the stroke represented by X.

Now, to determine the volume in cubic feet swept through by the piston, we multiply the length of the stroke, in feet, L, by the area of the piston, in square inches, A, and divide by 144. Then the volume represented by the line X will be equal to this volume of the piston displacement, in cubic feet, times the length of X, divided by the length of Y. The volume per hour taken in by the engine will be equal to this volume represented by X times the strokes per minute times 60, and if w is the weight per cubic foot of steam at the absolute pressure, represented by the points M and N,

the weight of steam used per hour will be w times the cubic feet per hour. If we divide this weight per hour by the horsepower, it gives us the steam weight per indicated horsepower-hour, and expressing this as a formula we have,

$$Q = w \times \frac{X}{Y} \times \frac{L \times A}{144} \times N \times 60 \times \frac{1}{I.HP.}$$

The usual formula for indicated horsepower, P L A N ÷ 33,000, may be substituted in the above expression. We shall then have,

$$Q = \frac{w\ X\ L\ A\ N \times 60 \times 33{,}000}{Y \times 144 \times P\ L\ A\ N}$$

and cancelling out the common factors in numerator and denominator, L A N, and multiplying and dividing the numerical factors, we have left,

$$Q = \frac{w\ X \times 13{,}750}{Y \times P}$$

which is convenient and accurate for all cases where the pressure at the end of compression, E, is greater than the pressure at release, F. In this expression, X and Y are to be measured, in inches, directly from the card, w is obtained from the steam table, knowing the absolute pressure, N, from the card, and P, the mean effective pressure in pounds per square inch, is measured from the card.

E. L. Gere.

Horsepower of Belting

I notice in the April 1 issue an article on Why Treated Belts Should Not Be Overloaded, which I think all right, with one exception: that is the rule used in computing the horsepower of belting, which I suppose the belt engineer did not go into thoroughly. The rule alluded to is all right for rough estimate, and where the pulleys are the same size, making an arc contact of 180 deg.

The following rule is much better: To find the horsepower of belting for open drive, without idler, pulley diameters being equal or nearly so, single belts: Multiply the belt speed per minute by the width of the belt in inches and this by 55. Divide the product by 33,000. The quotient will be the amount of horsepower any good single belt will safely transmit and is thus explained: F.P.M. × W × C ÷ 33,000 = Hp. Where F.P.M. = feet per minute, these are found by multiplying the diameter of the pulley in inches by 3.1416; dividing this product by 12 and multiplying by the revolutions per minute will give you the feet. Where W = the width in inches and where C = 55 lb., the constant for effective pull for single belts, for 180 deg. arc contact; this is the difference in tension between the tight and slack side of single belt.

For 2-ply belts under same conditions, multiply the result gained above by 1.6; for 3-ply, by 2. To find the constant C in the above formula when the arc contact is less than 180 deg., first: The number of degrees in the arc contact can be arrived at by multiplying the difference between the diameter of the pulleys in inches by the constant 4.75, dividing the product by the distance between the pulley centers in feet and subtracting the quotient from 180 deg. gives you arc contact. Second: To find constant C, multiply the arc contact determined above by 55 and divide the product by 180 deg. Use this in place of 55 in the formula. For 2 and 3-ply belts, multiply result found in formula as before by 1.6 and 2.

Example: To find the arc contact, having given pulley diameters of 10 and 36 in. and the center distance between pulleys 12 ft.: 180 — (26 × 4.75 ÷ 12) = 169.71 deg. 169.71 × 55 ÷ 180 = 51.3, this being constant C, the pull in pounds. Where the arc contact is greater than 180 deg. in places where idler pulleys and cross belts are used an easy way to get the arc contact is to strike a circle, plot this with angles of 22½ deg. and then by actual comparison get your arc contact and proceed as above.

R. A. Dix.

Safety Valve Seats

In the March 15 issue, p. 322, is given a series of questions and answers entitled Boiler and Engine Questions. Question No. 6 asks, "Why is the seat of a safety valve beveled to an angle of 45 deg.?"

The answer appears to be reasonable, and is the one that the majority of engineers would likely give; but it is not conclusive in view of the following.

The Crosby Valve Company, of Boston, Mass., published in 1913, a pamphlet entitled Hints on Safety Valves for Steam Boilers. In this pamphlet both beveled and flat seated safety valves are discussed at length, but preference seems to be given to the flat seated valves.

Allow me to quote a few passages from that interesting pamphlet that are worthy of consideration in connection with the subject. From p. 9: "Having flat, horizontal seats, the discharge for any assumed vertical movement of the disc is practically 1½ times as much as can be obtained through the diagonal passage between the seats of the best bevel-seated valve. In locomotive service, the Crosby flat-seated valve has demonstrated its peculiar advantages for more than 30 yr."

Again, on p. 11, the following appears: "The seats are made flat, not only because of the more direct and much greater discharge afforded, but because they are more durable in service, less cut by steam and dirt, more easily kept tight to avoid all leaking, and more accurately and quickly repaired and refaced, simply by rubbing or regrinding upon a face-plate, when damaged by boiler scale or grit. The disc is made entirely without guides in the steam space, and cannot cock or stick."

On page 14, it further states: "Specifications covering boiler safety valves issued by the Bureau of Steam Engineering of the U. S. Navy require that—

"The angle of the valve seat will be as near 0 deg. as practicable and not exceed 45 deg. from the horizontal."

Continuing: "Flat-seated valves are also approved under the rules of the Board of Supervising Inspectors of the U. S. Steamboat Inspection Service. It is now 30 yr. too late to question the efficiency, the relative desirability or the practical satisfaction in the use of annular, flat-seated safety valves. . . ."

In view of the foregoing, what is the experience of readers of Practical Engineer as to the relative merits of the 2 kinds of valves, and why are bevel-seated valves generally preferred in spite of what has been declared by such a company as the Crosby?

C. J. Mason.

To Discover Leaky Check Valve

I AM inclined to think that G. H. Wallace is a bit mistaken, or at least vague, in his answer to question 4, page 367, April 1 number. He says, "I cut off all the radiators, or as many as possible, and then hold the hand on the system side of the check valve and note whether the return pipe continues to warm up toward the system."

This answer would give the impression that, by shutting off the radiators, the pressure is reduced in the return piping, or that it is shut off altogether. In this case, one would surmise that the hotter water leaves the boiler through the return because there is less pressure in the return piping. Or it is possible that Mr. Wallace means that, by shutting off the radiators, the circulation is stopped through the system and the return piping will heat by the circulation caused by the difference between the weights of hot water in the boiler and the cooler water in the returns.

It should be remembered that on gravity return systems the check has no effect on the operation of the system. The check is put on as a precautionary measure. Plenty of gravity return systems are working well without them. But because there is the same height of water in the return piping as there is in the boiler, a leak in the returns has the effect of a leak in the boiler, unless a return check is put on.

Shutting off radiator has no effect on the pressure in the return piping, unless the radiators are piped in series, which is something unheard of in practice. If they were set in series, shutting off one would shut all off.

It is possible that Mr. Wallace means that shutting off the radiators and banking the fire will cause a vacuum and the water will lift up in the returns. This is not so in practice, because in a gravity return system the pressure is the same all over the system, and if a vacuum were in any part, it would be so in every part of it. At least, if there is a slight difference in pressure in any part of the system, it is so quickly overcome that it cannot be noticed by any change in the temperature of the return piping.

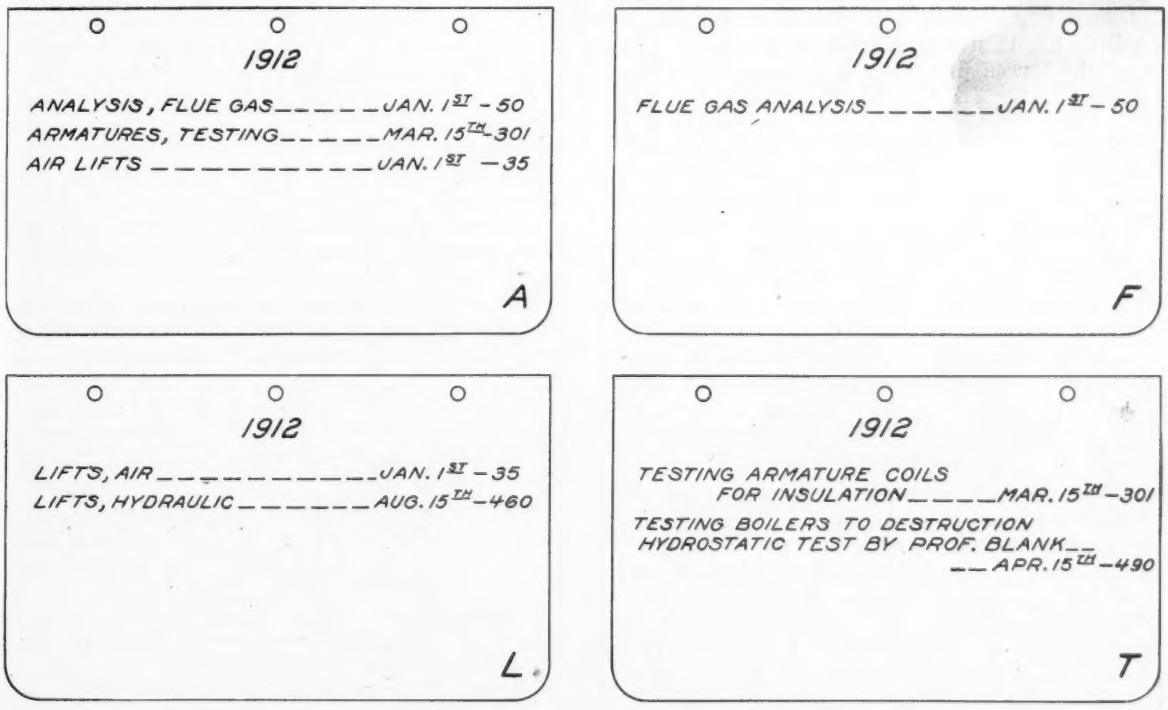
There are only 2 ways by which a leaky return check can be discovered. Shutting the main steam valve and watching the water glass is one, and is most unsatisfactory and uncertain. The other is to disconnect the piping outside check valve and see what water leaks back from the boiler.

All of this refers to the ordinary, well laid out system.

PATRICK J. DOWNEY.

Using Back Files

I FIND that the back files of Practical Engineer, which I have carefully indexed, are frequently consulted and that the reference is greatly facilitated by the plan herewith shown. I procure a loose leaf pocket book with alphabetical tags, and as each issue is read, have the book with me and put down page and date of article under its proper heading, as shown in the sample pages.


1912
ANALYSIS, FLUE GAS _____ JAN. 1ST - 50
ARMATURES, TESTING _____ MAR. 15TH - 301
AIR LIFTS _____ JAN. 1ST - 35
A
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FLUE GAS ANALYSIS _____ JAN. 1ST - 50
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LIFTS, AIR _____ JAN. 1ST - 35
LIFTS, HYDRAULIC _____ AUG. 15TH - 460
L
1912
TESTING ARMATURE COILS FOR INSULATION _____ MAR. 15TH - 301
TESTING BOILERS TO DESTRUCTION HYDROSTATIC TEST BY PROF. BLANK _____ APR. 15TH - 490
T

METHOD OF CROSS INDEXING

Cross-indexing may be used, and thus one has at hand a reference work of specialties better than any library volumes, on any subject pertaining to the power plant. By using a pocket book, as above mentioned for one year, the reference books may be divided into the unit system, so that a large amount of subject matter can be always at hand and readily found with the least expenditure of time.

H. J. GEAKE.

Successful Kinks From The Plant

For Saving Time, Work and Trouble

Engine Room Kinks

I WAS putting in some new blowoff pipe and the piece that goes into the boiler wouldn't come out, so I devised the tool illustrated. I sawed a slot through a piece of ½-in. pipe and then cut a slot crosswise of the pipe to hold one end of the blade 6 in. from the end, leaving the end for the handle. The wing nut and bolt of another hack saw frame can be used at the other end. I put a washer over the end of the pipe and set the blade so it would cut the pipe but not the threads; that is a little less than the thickness of the pipe. Then I cut off the blowoff pipe about 2 in. from the bottom of the boiler, took my hack and ripped the nipple in 2 places and it came out easily. This saw is also good to rip nipples out of unions as you can get it in a pipe or fitting ¾ in. or larger.

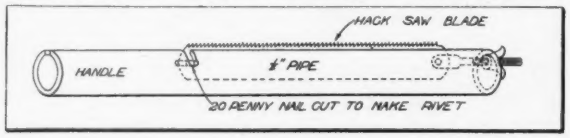


FIG. 1. CONVENIENT HACK SAW

Once I was called in to see an engine that had just come back from being overhauled. The shop men had done everything in their power to get the governor to regulate. They had bored the collar out, then bushed it with brass and forgot to cut off the screw that holds the trip block on, so when they screwed down tight to get the trip plate tight on the collar the end of the screw forced the brass bushing out of round. I cut off ⅛ in. from the screw, put it back and with a little adjustment the governor regulated nicely.

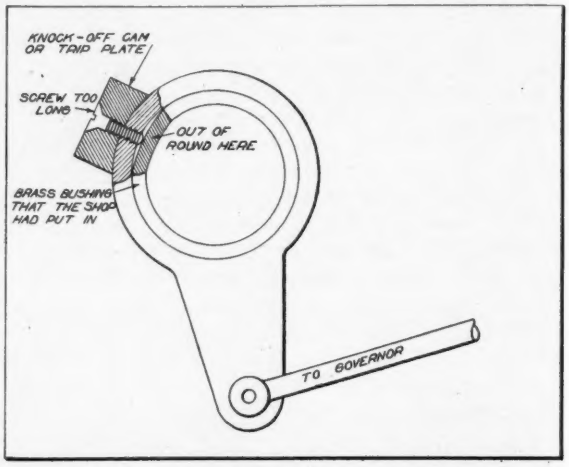


FIG. 2. DISTORTED BUSHING ON GOVERNOR

To cure hot dynamos when carrying a big overload, bend ⅜ or ½-in. pipe in a circle, drill a number of small holes next to the armature and connect it with a tee to the riser. When the machine begins to heat up, open the air cock and adjust air. It is well also to keep the armature and fields clean. The pipe circle can be covered with a piece of hose if necessary to avoid possible shorts by its being knocked over against the machine while it is generating.

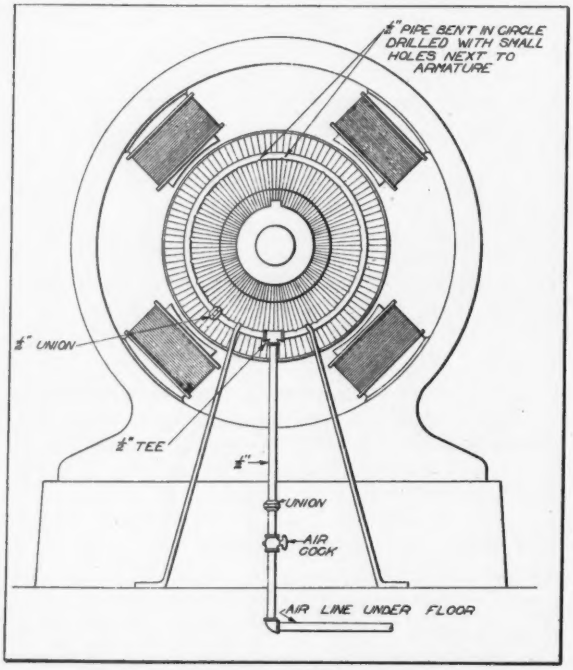


FIG. 3. AIR PIPE FOR COOLING GENERATOR

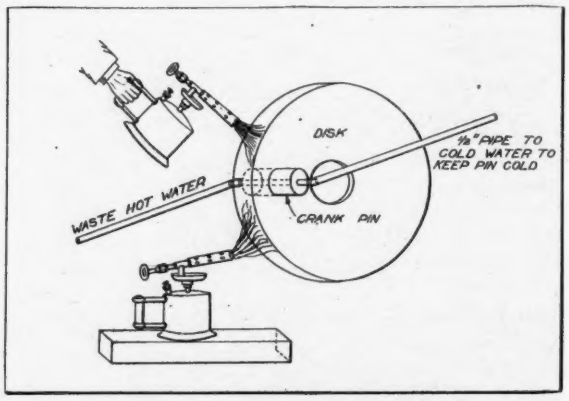


FIG. 4. REMOVING CRANK PIN

Figure 4 shows how I got a crank pin out in 3 hr. I drilled a hole through the pin, tapped it for ½-in. pipe and connected it to the cold water hydrant with a hose. I then took 2 blow torches and got the disk hot and drifted the pin out in a few minutes with a sledge. Another crew had chipped the bead off the back end of the pin and had worked 36 hr. in trying to remove the pin but failed. A brick furnace can be used in case there are no blow torches handy. FRED V. BROADAWAY.

Improved Back Pressure Valve

AN ENGINEER took charge of a plant provided with an old-fashioned back pressure valve which, not being provided with any cushioning device, soon leaked. Figure 1 shows that an iron bar was provided with several holes and a pin, that was used to limit the opening of the valve to secure the desired back pressure.

The engineer took off the bonnet and, placing some ground glass on the seat, proceeded to grind the disc and seat together, finishing the process by applying clear oil to the surfaces. The surfaces were wiped clean and about a gallon of water put on top of the disc required a day and night to leak away.

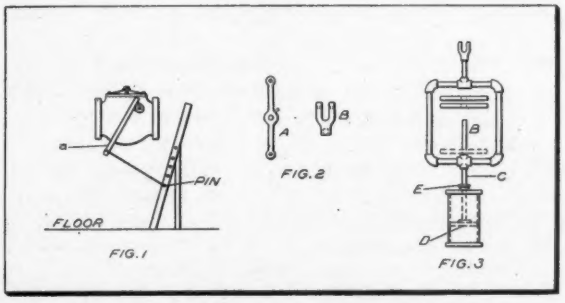


FIG. 1. TROUBLESOME BACK PRESSURE VALVE
FIG. 2. CASTINGS MADE FOR BACK PRESSURE VALVE
FIG. 3. FRAME FOR WEIGHTS AND DASHPOT

Wood patterns were made and from these castings A and B, Fig. 2. The lever A replaced the lever a, Fig. 1, and was placed in a horizontal position. The jaw B was drilled and tapped for 1-in. pipe, and the frame, Fig. 3, was made up. Some flat cast-iron weights were made, to be placed on the nipple, B, to secure the desired back pressure.

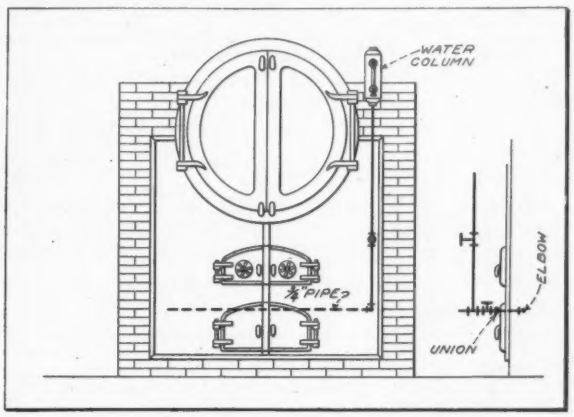
The lower nipple, C, was screwed into a 6-in. blank. A piece of 6-in. pipe 14 in. long was bored out smooth and the blank, D, made a good working fit. A cap was screwed on the lower end and another with a 1¼-in. bushing provided on the upper end. The pipe, C, moved up and down in the pipe, entering through the bushing, E.

A ⅛-in. nipple and valve is used to regulate the escape of air from the lower side of the disc, D. This work has been in successful use 3 yr. RECEIVER.

PERSISTENCY is a characteristic of all men who have accomplished anything great. No matter what opposition they meet, or what discouragements overtake them, grit carries them through. Of such men people say, "You can't down them."—System.

Ash Spray

IT IS an unpleasant job for a fireman to draw ashes out of the ash pit, raising dust and dirt, so I devised the following scheme: There is a connection on the water column pipe that runs into the ash pit. I put a tee just before it turns in the ash pit and from there I made the connection to a tee up behind the feed pipe and a special connection to the water tank. If you have it on the front of the feed pipe it makes a bad showing. We run on low pressure and water is plentiful. Between the tee and the ash pit, I put a valve and a union.



CONNECTION TO ASH SPRAYING DEVICE

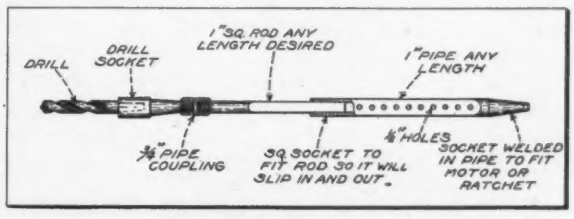
I put an elbow on the pipe that runs from the tee into the ash pit and from this elbow I ran a ¾-in. pipe across the ash pit just over the door. This pipe has about 12 holes in it to give it a good spray lengthwise in the ash pit.

I have tried hose connection and all kinds of connection, but I think this is about as good a connection as you can put on a boiler because it is always there. Just before you draw the ashes, open the valve and you have a nice spray of water across your ash pit.

C. M.

Extension Drill

FREQUENTLY the conditions of a job are such that an extension drill can be used to good advantage and I made one out of a short length of pipe, as shown by the accompanying sketch, which is used with an air


DRILL
DRILL SOCKET
1" SQ. ROD ANY LENGTH DESIRED
1" PIPE ANY LENGTH
¾" PIPE COUPLING
SQ. SOCKET TO FIT ROD SO IT WILL SLIP IN AND OUT
½" HOLES
SOCKET WELDED IN PIPE TO FIT MOTOR OR RATCHET

HOMEMADE EXTENSION DRILL

motor, but can be used equally well with a ratchet. The rod with drill may be slipped in or out and the ½-in. bolt dropped through the hole in the pipe to hold it at the desired length. T. M. STREET.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Boiler Questions

WHAT WOULD you consider the weakest part of a locomotive boiler?

2. How are the large type supported?

3. What would cause a tube of a Hazleton Porcupine boiler to curl up at the end?

4. Describe the tool used to expand the nipples in the mud drum of a B. & W. boiler. C. H. B.

ANSWERS

YOUR question No. 1 is difficult to answer, as it seems that no 2 locomotive boilers fail at the same place, except, perhaps, crown sheet failures, which in 99 cases out of 100 are due to low water. But we cannot say that the crown sheet is the weakest part, for if the water is kept at the proper level, the crown sheet will last longer than the remainder of the firebox.

The side sheets of a firebox give out most rapidly on account of the intense heat, which causes a rapid expansion, and a rapid contraction caused by knocking out the fire at terminals or the injection of too much water at a time the fire is low and the engine standing still for some time. But the barrel of a modern locomotive boiler and the outer sheets of the firebox are built a great deal like the "one horse shay," one part seems to be just as strong as the other. The uneven expansion and contraction of the shell caused by comparatively cold water entering the boiler and dropping to the lowest points, and the decayed vegetable matter which enters the boiler, cause a pitting in the belly of the barrel, which eventually weakens the girth seams and the lower part of the boiler. There is one type of locomotive boiler, called the Bellpare, which has a weak place, more noticeable than any others, and that is at the top of the connection sheet between the circular shell, or barrel, and at the top of the roof-sheet over the firebox. There is an uneven movement at this point which causes the sheet to crack.

Mechanical engineers who specialize on boiler construction, and especially locomotive boilers, all over the country have made a study of boilers and their weak points and have endeavored to overcome them with good results, so that now when we hear of the explosion of a locomotive boiler, we can say without fear of contradiction that it is generally due to a defective spot in the sheet which seems beyond human ingenuity to eliminate, poor workmanship, or carelessness.

2. Your second question is somewhat vague, for we might say that these boilers are supported by the rails and ties, and still truly answer the question, as far as actual support is concerned. If the boiler itself is meant, we can say that it is supported by its cylinder saddle, to which it is bolted or riveted, and by expansion plates; also, by expansion buckles fastened to sides of firebox and resting on frames, which allow a general movement of the boiler backwards from the saddle, as expansion takes place.

But possibly internal support may be meant. The modern boiler is stayed on the flat surface above the front flue sheet and above firebox on the back head, by either circular or flat braces extending from T irons riveted to these flat surfaces and to the shell. The dome is self-supporting and, instead of braces to hold the head, it is oval, or bumped or dished, as it is called, and the shell reinforced around the opening cut out for the dome. Around the firebox, staybolts and radial bolts are used almost entirely; Tate flexible bolts, used almost entirely on all modern boilers, permit great freedom of movement demanded by present day practice, between the firebox and outer shell.

3. Circulation in this type of boiler is comparatively poor on account of the steam globules rising to the surface in the central drum past the open end of the tubes. Of course, water enters these tubes; but as it has to enter and leave at the same end, this does not tend to promote good circulation. The water at the extreme end of the tube naturally is more or less dead, and being subjected to the greatest heat, rapidly evaporates so that the end of the tube is practically filled with steam only. This becomes superheated and, as this condition exists for long periods, it naturally follows that the tube becomes heated also, particularly at the bottom, where the expansion, being greater, causes the tube gradually to curl up at the end. Then, the more it turns up, the more the circulation is retarded and the greater will be the curling effect.

4. In the B. & W. and also a number of other equally well known water-tube boilers, it is necessary to put in short tubes or nipples between the manifolds and the throat sheet, in awkward places as far as the manual operation is concerned. To expedite this work, an ordinary roller of the desired size is used, but with an extended expansion rod provided with one or possibly 2 knuckle joints as the case may require. As the roller is short and can be put in place handily, the expansion rod is then inserted and the end brought out to a convenient place of operation. In this manner, it is possible to roll tubes in almost any conceivable position liable to be encountered in high grade boiler construction.

GEO. H. WALLACE.

Soldering Flux

CAN I USE a copper soldering flux for soldering zinc, without injuring the zinc? It is necessary that neat, durable as well as good electrical connections should be made. If you recommend a special flux, can it be used for zinc to copper connection? E. T. W.

A. The soldering fluid is not a flux, but is simply a material for cleaning off the metal surfaces, getting off all grease and dirt, so that the solder can adhere.

Muriatic acid neutralized with zinc clippings is the oldest and most common form, but there are a number of stick pastes which are more convenient to use and are commonly used by electricians for soldering wire and electrical connections. The same fluid is good for all metals. A. L. R.

Coal Consumption Problem

How much coal will be required to supply a flow of steam through a 1-in. pipe into a tank of water for 1 hr.? Steam is under a pressure of 100 lb. H. C.

A. The only means we would have of estimating the steam which would flow through your 1-in. pipe would be from Napier's formula for the flow of steam from an orifice. This contemplates the flow without any resistance, and taking the pressure just back of the orifice, so that we should have to subtract from the results, we get something to allow for the friction in the pipe and valve, and something to allow for the friction of the steam escaping through the liquid or condensing in it, but we can get an idea of how the matter would work out, which I presume is what you have in mind. The rule is as follows:

Where the pressure outside the nozzle is less than 0.5 the pressure inside the nozzle, the pounds of steam per second will be equal to the absolute pressure times the area of the opening in square inches divided by 70. This rule is based on experiment, and has no foundation in mathematics or in theory.

Taking your values, the pressure absolute would be 115 lb., the area for a 1-in. pipe would be 0.86 sq. in., and we would find the flow of steam per second by multiplying 115 by 0.86 and dividing by 70. This gives the pounds of steam per second, and multiplying by 3600 gives the pounds of steam per hour, then dividing by 7, assuming that we get 7 lb. of steam per pound of coal, will give us the coal per hour, which works out to 726 lb. A. L. R.

Transmission Line Economies

How much loss will there be to transmit 90 hp. 10 miles at 5000 v.? At 10,000 v.? How much copper will be required in each case? Which will be best, 5000 or 10,000 v.?

2. Will single phase or 3 phase be best and will there be any difference in the amount of copper or the loss in the line?

3. What is the approximate cost of such a line complete? E. A. K.

Answers

Ninety horsepower equals 90 times 0.746, or 82 kw. At 80 per cent power factor, this becomes about 100 kv.a. Ten thousand divided by 5000 equals 20 amp. to be transmitted if 5000 v. be chosen as the transmission voltage. If we allow a 10 per cent line loss we will have 5000 v. times 0.10, equals 500 v. drop in the transmission line; or 500 divided by 2 times 10 equals 25 v. per mile.

Twenty-five divided by 20 equals 1.25 ohms per mile. From the wire table, this would be about a No. 4 B. & S. wire. At 10,000 v., this same size of wire would give a line loss only half as great. For the same line loss at 10,000 v., the transmission line would electrically have to be only half as heavy or, say, about No. 6 or No. 7. Using No. 6 wire with 5000 v. would give a line loss of about 800 v., which is not excessive. It is hard to say what the smallest allowable wire for mechanical strength should be because local conditions vary this to a large extent. However, No. 6 is a fair size for moderate condition and we may assume that it is the smallest wire you may use. On this assumption, a single-phase, 5000-v. line would be the cheapest in your case, and a 5000-v., 3-phase line most convenient if you are to have a motor load. The extra cost of a 10,000-v. line would not be warranted by the saving in the transmission of 100 kv.a., and as you would use the same size wire in both cases, there would be no saving in copper to offset the higher cost of insulation and apparatus.

Your losses on a single-phase transmission line would be 20^2 amp. times 21.6 ohms (resistance of No. 6 wire taken as 0.411 ohm per 1000 ft.) or about 8640 w. per wire.

On a 3-phase line your current would be 100 divided by 5000 times 1.73, or 11.5 amp. The loss would be $11.5^2 \times 2.160$, or 2900 w. per wire.

3. Without knowing your market conditions and what kind of a transmission line you want to build, as well as the character of the country through which it is to pass, it is impossible to give even an approximate estimate of the cost of a line similar to yours.

V. E. Johnson.

Excessive Generator Speed

I have a 130-hp. Fleming-Harrisburg engine, running at 300 r.p.m., and with a flywheel 54 in. in diameter, belted to a generator the pulley of which is 21 in. in diameter.

The speed of the generator as specified on the name plate should be 752 r.p.m. What is the actual speed at which it is now running?

I am using 275-v. lamps and although our voltage is but 250, the lamps burn out continually. What is the cause of that? E. A. A.

A. A simple rule to calculate pulley speeds and diameters is, that the product of the diameter times the speed of the driver is equal to the product of the diameter times the speed of the driven. Knowing, therefore, any 3 of the above, it is a comparatively simple matter to calculate the fourth.

In your problem, you have an engine speed of 300 r.p.m., and a driver diameter 4 ft. 6 in., or 54 in., and a driven pulley diameter of 21 in. Multiplying 300 by 54, and dividing the product by 21, we obtain 771.4 r.p.m. If, therefore, your engine makes 300 r.p.m., neglecting slippage of the belt, the driven pulley will, as just stated, run at 771.4 r.p.m.

You state that the speed of your generator should be 752 r.p.m., and I presume you have obtained this value from the name plate on the machine. Such being the case, you are, therefore, operating at 771.4 minus 752, or 19.4 r.p.m. too high.

Judging from this higher speed at which you operate, and the fact that your lamps are continually burning out, I would say that your voltmeter must be indicating wrong, and would advise you to check your voltmeter with some other instrument known to be accurate.

At the same time, I would suggest that you reduce your engine speed so that your generator will be driven at the speed specified on the name plate. O. H. H.

Boiling Point of Ammonia

KINDLY GIVE me a table or rule by which I may determine the boiling point of vaporization of aqua ammonia at various degrees Beaume.

If my reasoning is correct, this must be lower than the boiling point of water; that is, the ammonia will evaporate before the water, depending upon the temperature and degree of saturation. SUBSCRIBER.

A. You are right that, as a rule, with the percentages of aqua ammonia in common use, the boiling point will be below that for water, but we do not know of any rule that has been worked out along this line. There is a table given on the Properties of Ammonia Liquor in "Siebel's Compend of Refrigeration," which embodies the results of experiments made by Star. The temperature depends, of course, on the pressure as well as on the percentages of ammonia in the mixture. At atmospheric pressure, it runs like this:

Per Cent Ammonia	Deg. F.
1	206
2	201
5	185
10	160.8
15	139
20	119
30	85.8
35	72

These are the percentages of ammonia by weight. They correspond about to

Per Cent Ammonia	Deg. B.
1	11
5	12.9
10	16
15	18.5
20	21.3
30	26.5
35	28.8

The table as given in Siebel's runs from zero gage up to 180 lb. gage by steps of 5 lb. pressure, and includes percentages by weight from 1 per cent up to 38.2 by steps of one per cent, and from Beaume degrees 11 up to 30. A. L. R.

Fire Cracks

WHAT CAUSES fire cracks in a boiler and how may they be prevented? J. H. G.

A. Fire cracks are problems which present different angles for consideration with each succeeding occurrence, and may be caused by poorly designed seams, door rings, dirt, improper setting or suspension, punched rivet holes, thick plates and continuous overload.

Improper firing is also a common cause, the rise and fall of furnace temperature causing a corresponding change of contraction and expansion, which in time causes the metal to become brittle at its weakest point or point of greatest molecular activity.

The remedy lies in a close diagnosis of the case and the elimination of the cause in question. An externally fired boiler developed fire cracks at the first girth seam. A study of conditions and furnace temperatures proved that the hottest point of fire was at this seam, which, being double, promptly burned and cracked. Further cracking was prevented by springing a small deflective arch across the furnace at a point directly under the girth seam. J. H. COATES.

Lateral Motion of Engine Shaft

IN THE plant of which I have charge, I have, among other units, a noncondensing single Skinner engine, direct-connected to a 50-kw., d.c. generator running at 280 r.p.m.

This engine has been running about 20 hr. a day for 2 yr. since it was new. Recently it has, however, developed a little wabbling of the flywheel. It is not much, but it can easily be seen if one stands in front of the flywheel while the engine is running. The flywheel is not loose on the shaft, and there is practically no knock in the bearings.

Will you please tell me what the probable cause is of wabbling, and how to remedy it? Can you give me a method to prove the "squareness" of shaft without taking off cylinder heads or disconnecting the crosshead? J. F.

A. As you say that the flywheel of your engine is not loose on the shaft, the problem is not a wabble in the sense in which that term is usually used, but rather a lateral motion coupled with perhaps a slight wear in the main bearing which is not enough to cause any noise owing to the cushioning of the oil which is applied by the splash system.

When an engine has been running 20 hr. a day for 2 yr., it means that there has been lots of work done and not much time to look into the general running conditions, as would be the case with fewer hours, no matter how good the engineer might be.

Twenty hours a day means 338,000 revolutions, and keeping this up for 2 yr. means a total of 246,740,000 revolutions.

When an engine is in operation, there is always a tendency towards lateral motion and especially so if the field frame of the generator has been set precisely in the neutral position, where there is little or no restraining influence to counteract lateral motion.

The writer has overcome just such a difficulty as you experience, by setting the field frame over toward the outboard bearing about 1/32 in., in which position the magnetic pull is just enough to retard lateral motion.

You will, no doubt, find that a thickness gage will reveal considerable lost motion between the jaws of the main bearing and the crank disc and collar.

Take out both front quarter boxes, and with an inside caliper, measure from the jaws over to the shaft on each side, both at the disc and at the collar. Providing

that there is no great amount of wear on the shaft bearing, you can, with a careful touch, tell if the shaft is out of alinement, and if so, by moving the adjustable outboard bearing as required, the shaft can be re-alined quite accurately.

If you find that the lateral motion is enough to warrant it, a good plan is to drill the ends of the quarter boxes, at whichever end is convenient, with a ⅝ or ¾-in. drill, say ½ in. deep well anchored with ¼-in. holes, and fill with babbit. Then file this babbit down till the boxes are a good running fit, and the end play will stop. G. H. WALLACE.

Heating Water in Air Compressor

CAN A MIXTURE of air and water be compressed in a cylinder so the heat of compression will convert the water into steam, the water entering the cylinder in the form of spray or vapor and at a temperature of 200 deg., the air being at the same temperature?

If this can be done, what are the conditions necessary to bring about this operation? D. F.

A. Although in the act of compression the temperature of air rises high, the actual heat units represented are very few and would have no practical vaporizing effect upon even small quantities of water. Water jacketing is necessary for air compressor cylinders to keep their temperature down; but it is surprising to note how slowly the water is warmed—it would be scarcely proper to say heated. At the high speeds at which compressors are now ordinarily run, compressing by single-stage up to say 60 lb., or by 2-stage to 100 lb., the temperature of the jacket water, when flowing quite leisurely through, hardly rises above blood heat.

It is a curious fact that a proposition just the reverse of this has been a standing challenge to engineers for more than half a century. The Cloud engine, and many other contrivances, have proposed to get a cheap accession of power by injecting a considerable charge of air into a steam cylinder at each stroke and then letting the heat of the steam increase the volume and the power value of the air. Something may be said for this as to its theoretical feasibility, but nothing of practical and permanent value has ever developed from it.

FRANK RICHARDS.

Lubricating Troubles

I AM running a 13 by 8-in. vertical engine, on which the oil works out onto the ends of the boxes and the shaft, from which it is thrown onto the floor. The oil grooves are in good shape. How can I remedy this trouble? If the cap on one of the boxes is screwed down fairly tight, the oil, instead of running out on the shaft, will work up through the sight feed glass in the oil cup and run over the outside of the box. Once in a while this box will heat. Can you suggest a remedy?

A. R. M.

A. It is a little difficult to give detail instructions as to how you might overcome your difficulty without knowing exactly how your boxes are made. If they are of the kind which have an oil chamber beyond the bearing, which is supposed to catch the oil before it runs out along the shaft, the use of an oil slinger just beyond the oil grooves, so located that the oil will be thrown from the thin edge of this slinger into the oil chamber in the end of the box, will probably be effective. This slinger can be simply a piece of sheet metal clamped around the shaft, so that the oil is carried up to a thin edge and thrown off, instead of creeping along the shaft.

If there is no such chamber on the end of the box, you could arrange a little galvanized oil guard just beyond the end of the bearing, having it drain from the bottom, and fix an oil slinger to throw the oil into this guard; or you might arrange a little wiper of felt just beyond the oil groove, which would catch the oil and conduct it into a funnel, and from that into a drain pipe. A. L. R.

Proper Alinement of Crankpin

HOW WOULD you determine whether the center line of the crankpin is parallel to the center line of the shaft?

J. W. W.

A. In squaring up the crankpin with the shaft of an engine, and in order to determine with accuracy if there is any deviation, one must know the accuracy of the several parts that are used in connection with the operation.

Engine builders machine the 2 faces of a crank disk parallel as far as possible and bore for the shaft from one side and for the crankpin from the other. Yet there is always the chance (and the writer has known it to occur) that after facing one side and turning the disk over in the mill or lathe, a small chip might get under the disk, or a defective jaw might throw the disk out a small amount.

Such a thing as this would throw the crankpin out of square with the shaft, yet the hole for the shaft might be bored square with one side and the hole for the crankpin square with the other, and if one attempted to square both pin and shaft, each with its own face of the disk, he would not detect any error, yet the error would be there and would not be discovered if one took it for granted that both faces of the disk were parallel.

So, in order to do a good job in a case like this (which is the only kind to do), one must check up the several parts in connection with the case.

Remove the main bearing and the side shells, if possible, and caliper the shaft to determine if it has worn out of round. Then with a square of known accuracy, square the shaft with the crank disk. Here again one must be sure that the face of the disk has not worn off against the frame by use. Turn the shaft and test all around.

Now, do the same thing with the crankpin. Here is where you are the most liable to find error. With calipers or micrometers or a snap gage about 1/32 in. thicker than the disk and using a thickness gage to fill in with, measure the thickness of the disk itself between the machined faces, and if there has been any error in machine work, it can be quickly detected.

Even if all machine work has been done with absolute accuracy, unless great care has been taken in pressing in the crankpin, it may easily be "cocked" to one side, and especially so if the pin has not been well lubricated with white lead before pressing, to prevent cutting.

G. H. WALLACE.

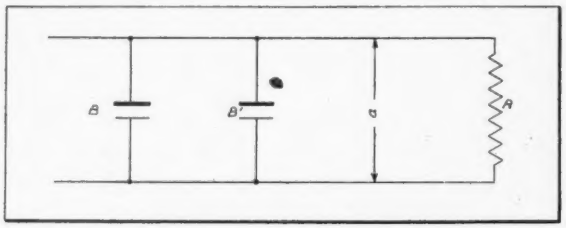
Problems For Discussion By Readers

What Would You Do If You Had These Conditions To Meet?

Calculation of Current Flow

THE FOLLOWING is the substance of an examination question recently asked me, which I wish some reader would kindly solve for me.

In the accompanying sketch, B and B^1 are 2 storage cells connected in parallel to resistance R.



CELLS B AND B^1 CONNECTED IN PARALLEL

B has an electromotive force of 1.8 v. and an internal resistance of 0.8 ohm, while B^1 has an electromotive force of 2.2 v. and an internal resistance of 0.4 ohm. R has a resistance of 1.6 ohms.

Neglecting the resistance of the wires, what is the electromotive force at A?

What is the total flow of current in the circuit?

H. G. H.

Some Massachusetts Examination Questions

EXPLAIN the difference between a Stirling and any other make of water-tube boiler.

2. If you had a boiler with 3 brackets and you required an equalizer, how would you put it on? Where would you place it? What is its use?

3. How would you figure the safe working pressure of a Stirling boiler?

4. How would you figure the safe working pressure of a Heine boiler? Of the water leg of a Heine boiler?

5. How would you figure the safe working pressure of a hollow staybolt?

6. What type of superheaters may be used on Heine boilers?

7. How would you lay out the cranks of a triple-expansion engine?

8. How would you calculate the required size of a hollow staybolt?

9. If the high-pressure side of a triple-expansion engine became disabled, how would you find the pressure required to carry the load on the remaining cylinders?

10. What is meant by a 3-stage turbine?

11. If a triple riveted butt strap joint has an efficiency of 90 per cent, what would be the required efficiencies of single and double riveted butt strap joints on a girth seam?

12. How would you repair a 21 by 30-in. bag?

13. How can water enter the cylinder of an engine used with a barometric condenser?

14. What is placed between the high and intermediate-pressure cylinders of a triple-expansion engine?

15. How would you conduct an evaporative test on a 60-in. return-tubular boiler operating at 160 lb. pressure?

16. Why is the cross-sectional area of a Manning boiler increased at the bottom?

17. Without a gage, how could you determine the amount of vacuum being carried?

18. How do you determine the strength of a flywheel?

19. With the vacuum breaker and injection valve in another room, what would you do, if, when shutting down your engine, you noticed that the pump was also stopping?

F. H.

Boiler and Engine Questions

ON PAGE 415 of the April 15 issue, C. Magnus criticizes G. A. T.'s answer on page 322 of the March 15 issue. I consider G. A. T. is nearer right than Mr. Magnus, who says regarding question 5 that he would get a new spring and then regulate the blowback. As a matter of fact, the blowback is controlled by the screw ring, which should be lowered, thus giving more space between the seat ring and disc, allowing the steam to escape more readily. G. A. T. should find out whether he can get enough tension off the spring to bring it to 160 lb. If he cannot he will need a new spring.

Regarding question 7, Mr. Magnus does not seem to think much of the practical part of superheating. In a vertical boiler of the Manning type the space above the water is filled with steam, which in passing through the tubes has its temperature raised about 25 deg. F.

W. N. L.

Oil Filter Trouble

REPLYING TO the inquiry of John H. Armstrong, on page 461 of the May 1 issue, in regard to the filtering of cylinder oil, I am sure he will get better results if he will discard his present equipment and rig up either of the 2 types of pressure filters shown in Figs. 1 or 2.

The stand pipe filter, Fig. 1, is the best if the building construction will allow for its installation. It must be in a reasonably warm place, the temperature not being below 80 deg. F. at any time. The top end should be at a height of at least 20 ft. above the filter proper to give sufficient pressure.

Giving a description of one which I know gave good results will be the easiest way to make the idea clear and easily understood.

A hole was bored through the second floor of a mill and a length of 2-in. pipe extended down through and into the engine room. This pipe, clamped in place, was connected to a funnel, having a screen fastened at its top end to receive the dirty oil.

An 8-in. blind flange was drilled, tapped and screwed on the bottom end of the 2-in. pipe. This made the top head of the filter. The filter itself consisted of a piece of 8-in. pipe 16 in. long with a cap on the bottom, drilled and tapped, and provided with a 1-in. nipple and gate valve for drawing off the clean oil. A flange on the top joined another on the 2-in. pipe.

An iron hoop was placed inside the 8-in. pipe, so as to hold the lower screen about 8 in. from the bottom, thus providing a reservoir for clean oil. Then about 2 in. of washed waste was placed on this screen with another screen above.

To clean a filter of this type, all that is necessary is to take the bolts out of the flange and renew the waste. Do not use new waste, as this will block up in a very short time.

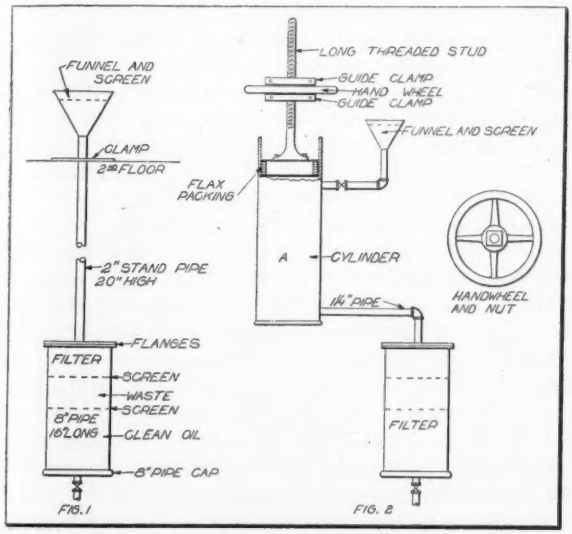


FIG. 1. STAND PIPE TYPE OF FILTER
FIG. 2. PRESS TYPE OF FILTER

This filter handled cylinder oil and gave no trouble so long as the temperature was not below 80 deg. F.

The other filter, Fig. 2, was made on the principle of a press, and is a little more costly to construct. Cylinder A was made of a piece of 6-in. pipe about 2 ft. long, and bored out to insure a smooth inner surface. The bottom end was capped.

A plunger, similar to those employed in the water end of a pump, was made of 2 plates ¼ in. thick and provided with a bull ring having an outside diameter 1 in. less than the inside diameter of the cylinder. This plunger was then packed with ½-in. square flax packing. The long threaded stud, made of ⅞ or 1-in. iron and about 3 ft. long, was fastened to the top plate by means of 2 rivets.

Two guide clamps were fastened to some rigid support about 4 in. above the cylinder. These served to hold the stud in a central position and also as a rest for a hand wheel for operating the plunger. The hand wheel was made by using a wheel from a large valve, the hole which fit over the square part of the valve stem having been enlarged enough to form a suitable holder for the nut which turns on the threads of the stud. By turning this hand wheel, the plunger may be raised and lowered in the cylinder.

This much of the apparatus makes the force pump or press which forces the oil through the filter.

The filter is made the same as the one used for the stand pipe and is connected to the bottom of the cylinder by means of a 1¼-in. pipe. The filter can also be attached directly to the bottom of the press in the same manner as on the stand pipe.

The cylinder is filled by means of a funnel and screen close to the top end.

When the press type of filter is used, even cold oil can be forced through and filtered, although warm oil will give better results. A. G. SOLOMON.

Commutator Lucricant

IN REPLY to the inquiry of H. G. H., in the May 15 issue, p. 503, in regard to the use of paraffin on commutators as a lubricant, I would say we use nothing else for our commutators but paraffin, for both generators and motors, also on the neutral ring, and find that it gives very good results.

In time it may gum the brushes a little, also it may get too thick on the commutator; we always keep the "sand-block" handy and smooth the commutator with it, and slip a strip of sandpaper under the brush to trim it. Always use a fine sandpaper, not emery cloth.

This treatment keeps the commutator smooth and glossy, as well as the brushes from "chattering." Do not allow the brushes to spark. W. G. I.

"IT IS REMARKABLE how few motorists realize the danger of running their tires in the car tracks," declares R. S. Wilson, Manager Service Department, The Goodyear Tire & Rubber Co. "It is true that a car runs easier, and the jolts to the mechanism are greatly reduced; but it is expensive comfort; there is no quicker way of ruining tires.

"The tread of a tire is the thickest part because there the greatest wear takes place. The sides have a thinner wall of rubber to protect the fabric. Now, when a tire is run in the car tracks the wear is concentrated on the side of the tread and the side walls. The constant contact of the tire and the inside surface of the rail causes abrasion or wearing away of the rubber. The rail soon cuts through and ruins the tire.

"This practice of running in the car tracks is also a common fault among drivers of solid tire trucks. Only the outside edge of the tire rests on the rail, and consequently only a small part of the tire sustains the whole load. The result is that the outside edge wears off while the rest of the tire is apparently in good condition. Take a 5-in. solid tire; constant running in car tracks will wear off 1½ in. of the surface, reducing it to a 3½-in. tire. Thus, a 3½-in. tire is compelled to do the work of a 5-in., which amounts practically to overloading.

"Car tracks must be avoided if full mileage is wanted."

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The Daily Friction Test

So much attention is paid nowadays to the question of economy in the production of power—that is, in any plant making pretense to efficiency in operation—that, in many installations, this important consideration is frequently allowed to overshadow another question of just as great importance. What becomes of the power generated is every bit as important as how cheaply it can be produced. Improvements in boiler efficiency, so directly reflected in the husbanding of the coal pile, and highest possible efficiency of the power generators must not be belittled in any way and should be continually striven for, as the cost of power at the flywheel, that available for subsequent operations for which the power supply is required, is dependent upon these conditions, but this is but half the battle for true efficiency.

No matter how economically power can be developed, it is valueless at the engine or turbine. It must be transmitted elsewhere and employed to accomplish some useful work. This means turning the wheels of industry of the plant and necessitates many preliminary operations before the power not expended in these preliminaries can be converted into anything that represents money, the primary and sole object of generating power in the first place. The preliminaries may consist of running systems of belts, distribution of power by ropes or gears, forcing a greater or less proportion of the mechanical energy generated at the engine through a conductor in the form of electrical energy—conversion of energy taking place after the delivery of mechanical energy by the power generators—but in any case they consume a certain amount of power that must be deducted from the supply furnished by the engine. It is only the balance of power that constitutes the net output of the plant, the power that really possesses monetary value.

Of course, any serious power losses are being looked for by the management at all times and when located are remedied as promptly as possible, but it is not the big losses that constitute the greater part of the power consumed by the preliminaries—it is the small inefficiencies. Each loss or waste may be quite trivial in itself, but in the aggregate they amount to a very considerable proportion of the power developed in the engine room.

Every aid in locating "friction wastes," classifying all consumption of power by the preliminaries as such, is of value and none is too trivial to be overlooked. Herein lies the main fault in many plants. Husbanding the coal pile and care in steam generation is important, but assuming that all is well because it costs no more to generate power today than at some previous time when it was believed that good economy was attained, cannot be taken as proof of constancy in efficiency, it may indicate, just as well, constancy in inefficient operation.

One of the greatest helps in controlling the "friction losses" is to make friction tests of the entire plant. By this is meant, measuring the amount of power consumed by the preliminaries by means of indicator cards taken at a time when all equipment and apparatus requiring power is in operation but when no useful work is being performed—for instance, in a factory, a plant power test made with every machine and piece of power consuming apparatus in full operation but with no work in

the chucks, etc., simply a measure of all power consumed in turning the wheels. Such a test made each day, before actual work commences, consumes but a short time and gives the average plant's "latent load" for the day. If the next day, the friction load appears greater, extra efforts should be exerted in locating the difficulty. If the same, it does not mean that any less attention than is ordinarily given will suffice, for, though the "friction losses" can never be entirely overcome, there can be no fixed allowable value for such—their complete elimination must be striven for, even if such ideal condition can never be realized.

When the "latent load" of the plant is finally reduced as low as it is possible to keep it with the apparatus at hand, the installation of more efficient equipment may be necessary before any further betterment in the "latent load" is possible. Something can always be done, however, and that something should be done. It is always bound to pay, and to pay well, in the long run.

News Notes

AT THE ANNUAL MEETING of the Society for Electrical Development, held at the United Engineering Societies' Building, New York City, May 11, the Board of Directors was unanimously re-elected, consisting of J. F. Gilchrist, W. A. Layman, J. R. Strong, F. S. Price and Charles W. Price. J. M. Wakeman, General Manager, read his report outlining the plans for Electrical Prosperity Week, to be held Nov. 29 to Dec. 4, the underlying idea being to arouse the interest of the public in the uses of electricity, and at the same time bring about a more optimistic feeling throughout the country in the effort to improve business conditions.

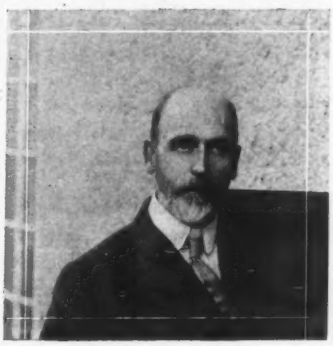
JUNE 6 TO 10, the 50th Anniversary of the founding of the Worcester Polytechnic Institute will be celebrated at Worcester, Mass., the exercises including the usual commencement program, and, in addition, dedication exercises at Alumni Field, and the laying of the cornerstone for the new gymnasium. General George W. Goethals will be present and speak, and it is hoped that President Wilson, who was commencement orator 25 yr. ago, will be able to attend.

ON ACCOUNT of the fact that all rooms at the La Salle Hotel, in Chicago, have been engaged for the week of the National Gas Engine Association's Convention, June 23 to 24, it has been decided to hold this convention at the Brevoort Hotel, in Chicago, and the management has promised to take care of all men in attendance at the convention, with no increase in rates.

FREDERICK HAYNES NEWELL, who has recently been appointed Professor of Civil Engineering and head of the Department of Civil Engineering of the University of Illinois, entered upon his duties on May 1, in order to be fully prepared for active work at the beginning of the next college year. He comes from active professional work, having been for 26 yr. in government service, principally as Chief Engineer and later as Director of the U. S. Reclamation Service.

Growing steadily but rapidly from a single individual, the organization expanded until several hundred engineers, technical and clerical assistants have been employed, and a force of upwards of 8000 laborers. The wide distribution of the work necessitated a quite elaborate and yet flexible organization, and the problems encountered have required the exercise of engineering and business judgment to a high degree.

In addition to his regular work for the government and his service on various boards and commissions, Professor Newell has given much time to various scientific and related organizations, having been secretary of the National Geographic Society and of the American Forestry Association, President of the Washington Society of Engineers, and a member of the American Institute of Mining Engineers, the American Society of Civil Engineers, etc.



His broad experience in discovering conditions, in initiating large work, in overcoming unusual difficulties, in attracting and holding men of high character and sharing with them an enthusiasm and a rare devotion to public service, leads to the belief that Professor Newell in his new position will be of substantial aid in maintaining and forwarding the high ideals of Illinois.

IN THE MAY 15 issue, on page 510, our attention has been called to some typographical errors appearing in the description of the Duplex Steam Trap. It is stated that the drums are brass lined. This should read, "the valves are brass lined." Also the name of the manufacturers is the Duplex Steam Trap Mfg. Co., instead of the Duplex Steam Pump Co.

EDWARD W. PARKER, who for many years has been the government coal statistician of the Division of Mineral Resources, has resigned from the United States Geological Survey and accepted a position with the Anthracite Mining Interests, where he will continue activity along lines in which he has previously served as an authority. Secretary Lane has appointed H. D. McCaskey to succeed Mr. Parker.

WALTER R. JENNISON, of Atlanta, Ga., has severed his connection with the Harrison Safety Boiler Works, and will in future devote his time to the interest of the Kerr Turbine Co., the Ball Engine Co., and the Wheeler Condenser & Engineering Co.

THE NAME of Culebra Cut in Panama Canal has been changed by an order issued by President Wilson, to Gaillard Cut, in honor of Col. D. D. Gaillard, who died of illness contracted in service at the isthmus.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Type AR Single-Phase Motors

THE Westinghouse Electric & Mfg. Co. has recently placed on the market a new line of single-phase motors which are being used extensively for the operation of small machines of all kinds. These motors are known as type AR and range in size from ½ to 10 hp., inclusive, for 60-cycle circuits.

These motors are substantially built, are light in weight and extremely compact. Motors of 2 hp. and larger are usually used for industrial service, and particularly strong mechanical construction with light weight and good electrical performance are highly desirable. For this reason, steel frameless construction is employed in these sizes of motors, and mechanically they correspond closely to the Westinghouse type CS polyphase motor which has proven so satisfactory. This type

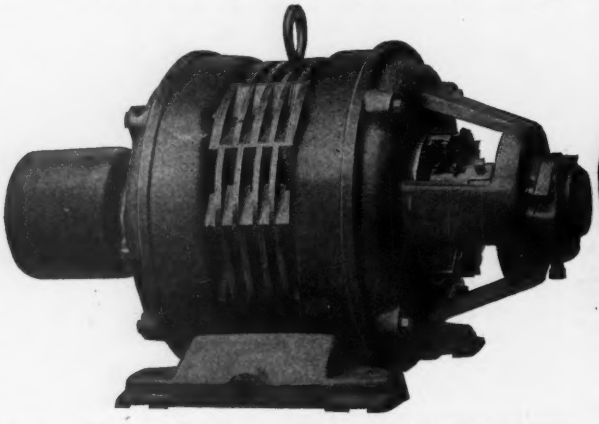


FIG. 1. TYPE AR MOTORS OF STEEL FRAME CONSTRUCTION

of construction is shown in Fig. 1. Smaller motors have strong cast-iron frames as shown in Fig. 2. All sizes of motors can easily be adapted for wall or ceiling mounting and may also be adjusted for clock-wise or counter-clock-wise direction of rotation in a moment's time. Any motor may be reconnected externally for operation on either 110 or 220-v. circuits.

The motor starts as a repulsion motor, producing large starting torque and taking only a small starting current. A simple, mechanically-operated governor, placed within the rotating element, automatically changes the motor from a repulsion to an induction motor as it comes up to speed.

Ordinarily, a double-pole line switch is the only starting device required, although starters can be furnished to reduce the starting current further. These motors have a broad application and can be used upon any single-phase circuit or any phase of a polyphase circuit.

The Use of Spindle Grease Cups

SINCE the first spindle cup made its appearance, many styles and kinds of spindle cups have been used with more or less success. The original theory covering the spindle type of cup has, in many instances, been lost sight of and the operation of the cup itself attributed to various makeshift theories which are without a sound basis. For instance, some advance the idea that the spindle resting on the shaft in a grease cup filled with a mineral or ordinary grease revolves, due to the rotation of the shaft, and in that way creates a disturbance in the midst of the grease in the cup, which causes the grease to flow and lubricate the bearing.

Others have advanced the idea that the spindle in a grease cup filled with a mineral or ordinary grease, works in a vertical direction through the grease and

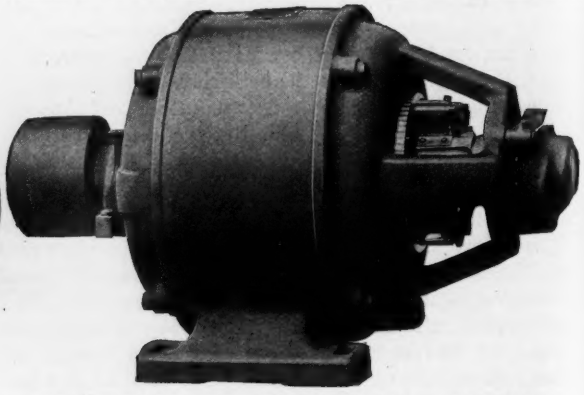


FIG. 2. SMALL SIZE TYPE AR MOTOR OF CAST-IRON CONSTRUCTION

in that way is supposed to hop up and down in the cup and practically poke or push the grease to the bearing. This movement of the spindle is supposed to be produced by the action of the shaft which has some free-play in the bearing.

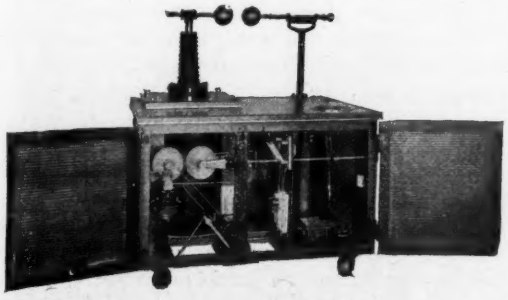
According to the theory or principle upon which the spindle cup acts, as stated by the Albany Lubricating Co., the spindle type of cup should only be used with a solid lubricant possessing a low melting point. By that is meant, a lubricant that will flow at a temperature ranging from 50 to 175 deg. F.

The spindle should be of soft copper sheathed from the bottom to about half its length with a corrugated piece of copper. As copper is a good conductor of heat, the copper sheathed spindle, resting on the shaft, feels every fluctuation in bearing temperature. This, due to the high conductivity of the spindle, is readily impressed upon a low melting point grease or compound which flows, reduces the bearing temperature to normal and

then solidifies again. In this way practical, automatic lubrication is secured. The spindle vibrates but little, does not revolve and does not hop or jump in the grease cup. Genuine Albany grease, a pure tallow compound, possesses a low melting point and can be used not only in spindle cups with great success but also in any other make or kind of grease cup.

High-Frequency Oscillator

ONE of the recent developments of the laboratories of the General Electric Co., and now commercially available, is the 125,000-v. portable, high-frequency oscillator, an outfit designed for the purpose of testing porcelain, high-tension line insulators and bushings by means of high-frequency, high-potential current. This equipment is built for operation on 25, 40, 50 and 60-cycle circuits and may be connected for 110 or 220 v. It requires about 1½ kv.a. at 25 cycles, 2 kv.a. at 40 cycles and 2½ kv.a. at 60 cycles, and will deliver current having frequencies of approximately 300,000 cycles at voltages up to about 165,000 v.



FG. 1. INTERIOR VIEW OF THE 125,000-V. HIGH-FREQUENCY OSCILLATOR

The function of the high-frequency oscillator test is to approximate conditions under which insulators fail in service; i.e., lightning surges, switching surges, arcing grounds, etc. Lightning comes in multiple strokes of extremely rapid succession, so rapid as to appear usually as one stroke. Switching surges are of comparatively short duration. Arcing ground surges may last several seconds or even minutes. The frequency will be high in every case, and there will also be a rise in voltage. With lightning, there is no limit to the potential except that which will cause a discharge from line to ground. With switching surges and arcing ground surges, the potential nearly always reaches double value, and may even exceed very much that value.

This high-frequency oscillator, as shown in Fig. 1, is designed for testing porcelain insulators only. It is best adapted to testing at the factory, laboratory or at some point on a transmission system where insulators are delivered or tested. The number of insulators that can be tested in multiple depends on the type of insulator. Five suspension type insulators can be tested in multiple at a test voltage of 80,000 and frequency of 300,000 cycles per second.

Where transportation conditions permit, the oscillator can also be used to test suspension insulators in place on the line and pick out defective ones, provided the spark potential of the individual disc is not greater than the voltage rating of the oscillator (125,000 v.). Under the same conditions the oscillator can be used to test any pin insulator, providing it is mounted on a dry wooden crossarm, or is mounted on a metal crossarm that is carried on a dry wooden pole and is not connected to a ground wire.

The essential elements of the high frequency oscillator are: a step-up transformer, 13,000 to 110 or 220 v.; a condenser placed across the terminals of the high-voltage coils of this transformer; an adjustable control gap; an oscillation transformer, oil immersed, with no iron core, consisting of a few turns on the primary and many turns on the secondary; a properly proportioned sphere gap; a suitable reactance to protect the step-up transformer against the damaging effect of short circuit when a spark takes place at the control gap.

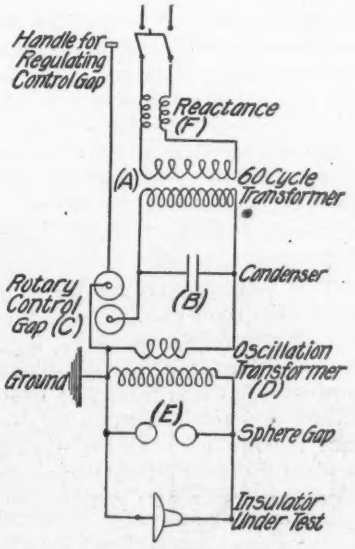


FIG. 2. DIAGRAM OF CONNECTIONS OF 125,000-V. HIGH-FREQUENCY OSCILLATOR

The oscillating current transformer consists of 2 concentric windings arranged vertically in a stoneware jar and immersed in oil. They are connected together at one end and grounded, the outer coil consisting of the few turns of copper strip wound on a form of treated wood. The ends of the coil are brought out through the stoneware jar under the oil and are connected to the condenser and spark gap. The condenser, as stated, is charged by the 13,000-v. supply transformer. The apparatus is supported in an angle iron frame mounted on casters and enclosed on all sides with perforated iron. A wooden cover is placed on top and supports the sphere gap.

Voltage is controlled by gradually opening the control gap, one electrode being grounded and connected to a rod extending through the side of the case, which permits manipulation while the arc is playing across the gap. The high frequency high potential across the sphere gap is read directly in volts off a graduated scale provided with the outfit. The fuses and disconnecting switches are mounted inside the frame, the main switch being connected by a rod to a handle just above the

control gap handle. These 2 handles represent the entire control of the apparatus, the element of the duration of test desired being readily governed by the switch handle.

Operation of this oscillator is interesting. Current at 110 or 220 v. is received at the low-tension side of the step-up supply transformer. The voltage across the high-tension side is then limited by setting the control gap, which is in series with the high-tension circuit of this transformer. As the voltage across the control gap increases, the condenser becomes charged; and when there is sufficient voltage to spark across the control gap, the charged condenser becomes short-circuited and a current surges back and forth through the circuit containing the condenser, the control gap and the low-tension side of the oscillating transformer, each surge of current being less in value than the preceding surge until the surges cease.

This is a damped oscillation and occurs always when a charged condenser is discharged through a circuit containing inductance and resistance. The oscillation is communicated to the high-tension coil, which is wound in a single layer. Forced oscillations are used in the oscillator, which distinguishes it from a wireless outfit. By using forced oscillations, the oscillator needs no adjustments for changes of natural frequency.

The real function of the charged condenser is to give additional energy and power to the discharge spark, inasmuch as it is quite possible for the control gap to arc over without the condenser. The oscillating transformer proper thus merely steps up the high-frequency voltage to the test values desired at the sphere gap. The air core is employed, as iron cannot be used with such high frequencies, and this transformer is immersed in oil to increase the insulation of the winding. A discharge takes place for every alternation of the generator wave, a 60-cycle generator thus giving 7200 discharges of high frequency per minute.

Use of Electricity in Shipyards

THE electrification of the F. O. Smith Shipbuilding and Dry Dock Co.'s Dry Dock at Norfolk, Va., is a notable example of the saving that can be effected by the use of electricity in shipyards.

Previous to July, 1912, the dry dock was operated by old-fashioned steam-driven bucket pumps. With this equipment, practically half a day was required to make a haul and occasionally trouble was experienced with the operating machinery. Being aware that with these defects the dock could not meet with great success, the owners sought for means to improve the operation and shorten the time required to lift a vessel. As a result of investigation, it was decided that electrically-driven pumps should replace the steam equipment. Accordingly, 12 20-hp., 1135 r.p.m. Westinghouse electrical vertical motors coupled to 10-in. Morris centrifugal pumps were installed.

The installation met with such immediate success that in February, 1915, another section was added and 6 additional pumping units, duplicates of the ones previously installed, were purchased and placed in position.

It is now possible with this new equipment to lift a vessel high and dry in 17 min. at an energy cost of about $4.50, whereas with the old equipment it required half a day and cost from $12 to $15.

The dock will accommodate any ship afloat not over 260 ft. long on the keel blocks or 3000 tons dead weight, and will be the means of increasing the revenue at the port of Norfolk by thousands of dollars annually.

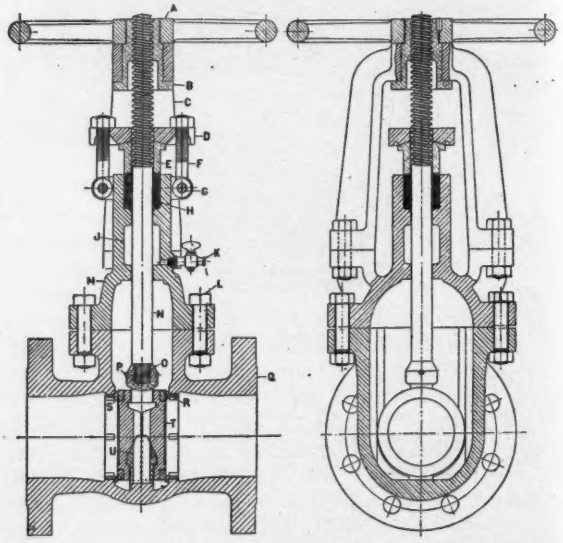
In addition to the electrically-driven pumps on the dock, the shipyard is fitted up with a very complete line of shipbuilding machinery, including air tools, modern machine boiler and blacksmith shops, the only marine railway in the world with a concrete foundation, a sawmill, and a Westinghouse electric welding outfit equipped also for cutting.

The motors are covered when not in use. Auto starters controlling the motors are mounted in a house so as properly to protect them.

McNab & Harlin Steel Gate Valve

IN the accompanying illustration are shown the cross-sectional views of an extra heavy, flanged, outside screw and yoke steel gate valve as manufactured by the McNab & Harlin Manufacturing Co., of New York.

As may be seen from the cut, this valve is built up of a cast steel body, Q, to which is bolted valve hood, M, also made of cast steel. The heavy cast-steel web type of



SECTIONAL VIEWS OF MC NAB & HARLIN STEEL GATE VALVE

valve yoke is bolted to the valve hood by means of steel gland bolts of the hinged type, thus allowing easy and ready access to the chamber, H, for packing. Stationary hand wheel, A, raises and lowers the Monel-metal valve stem, N, to the lower end of which is attached the 2-piece valve disc, T. The disc T slides between the 2 Monel-metal disc rings, S, so that, by means of the renewable seat rings, R, all leakage is avoided. Wedge nut, U, made of Monel metal, is of simple construction and insures a complete and efficient wedging device.

A valuable feature of this valve is the large condensing chamber, U, which traps the high temperature steam and protects the packing in the packing chamber, condensation being cared for by drip cock K.

Attention may be called to the steel gland, D, and bronze bushing, E. By the conical construction of the top of bushing E and the bottom of gland D, any unequal strain on nuts F will not interfere with the proper downward pressure of the bushing on the packing.

Civil Service Examinations

ILLINOIS STATE CIVIL SERVICE COMMISSION positions under Illinois Public Utilities Commission, for which examinations will be held in the near future, are as follows:

Mechanical Engineer—Salary, $160 to $250 a month. Minimum age, 25 yr. Duties involve charge of investigations of water works and steam heating properties with regard to valuations for rate making proceedings and special operating problems, and preparation of orders in water rate cases; requiring general familiarity with Illinois Public Utility Commission Law, the equivalent of graduation in mechanical engineering from an engineering college of recognized standing, together with experience in the operation, construction and design of mechanical equipment.

Service Engineer—Salary, $200 to $300 a month. Minimum age, 25 yr. Duties involve the directing of all routine service inspection of utility properties, special investigations as to service and preparation of orders in such cases; requiring equivalent of graduation from an engineering college of recognized standing, with thorough experience and ability in operation, construction or design of utility properties and their equipment; should be familiar with Illinois Public Utilities Commission Law.

Gas Engineer—Salary, $250 to $333.33 a month. Minimum age, 25 yr. Duties involve charge of investigation of gas properties with regard to valuations for rate making proceedings and special operating problems, and preparation of orders in all gas rate cases; requiring general familiarity with the Illinois Public Utility Commission Law; education equivalent to high school graduation, thorough experience in operation of gas properties, construction, and installation of gas manufacturing equipments; some knowledge of chemistry relating to composition of the various heating and illuminating gases, ability to determine operating expenses, prepare inventories, and valuate properties and compute rates.

Railroad Engineer—Salary, $250 to $333.33 a month. Minimum age, 25 yr. Duties involve entire charge of investigations of railroad accidents, examination of dangerous crossings, inspection for approval of interlocking plants and signal circuits, investigation of railroad service complaints, and preparation of orders in connection with railroads; requiring general familiarity with the Illinois Public Utility Commission Law; education equivalent to high school graduation, experience in responsible charge, in either construction or operating departments, and familiarity with design, construction and maintenance of interlocking and block signal devices.

Examination will be held simultaneously in Chicago, Springfield, E. St. Louis and other places in Illinois. For further information address W. R. Robinson, Secy. State Civil Service Commission, Springfield, Ill.

Book Reviews

COMPRESSED AIR PRACTICE, by Frank Richards, 326 pages, illustrated. Price, $3.00.

In this book, the general rather than the specific is taken up with the approximate rather than the precise discussion of compressed air problems. The book is intended for the many rather than for the few—for those who know little about air rather than for those who know about all that is known at the present time.

It starts with a chapter on atmospheric generalities, showing how air is used in our everyday life and the natural variations in pressure, and how Nature uses the atmosphere in supporting life and conveying moisture which is the source of all our water power. Following this is a chapter on definitions and general information, after which the author takes up the compressed air problem as it is encountered in industrial work, solving a number of these problems by means of tables and diagrams and showing the use of the indicator on air compressors. Then come chapters on single-stage, 2-stage and 3-stage compression, followed by a discussion of regulating devices for air compressors, and the driving machinery. A section of the book is then devoted to the turbo compressor, followed by a discussion of the Taylor compressor and the Humphrey pump. The power for compressing air and its cost are covered in 2 chapters, followed by discussions of the air receiver, transmission lines, reheating, compressor and receiver fires and explosions, and side lines for the air compressor. Then come discussions and descriptions of the various industrial uses of compressed air machinery, closing with a chapter on liquid air. The book is well written and makes good reading from the beginning to the end for anyone interested in industrial work.

AN INTERESTING PRIMER on Explosives, for metal miners and coal men, is published by the Bureau of Mines, Department of the Interior, as Bulletin No. 80. This is fully illustrated, giving exactly the method of handling different explosives, with a description of each, its physical composition and action, shows how to use the explosives, and gives the results of a number of tests on different methods of handling. The book contains 120 pages of valuable information to those engaged in the class of work mentioned.

To those who have special reason for wishing it, a copy will be sent free as long as the first edition lasts. After that, copies can be procured at the price of 25 cents each.

THE EFFECT OF BORON UPON THE MAGNET AND OTHER PROPERTIES OF ELECTROLYTIC IRON MELTED IN VACUO,' by Trygve D. Yensen, has just been issued as Bulletin No. 77 of the Engineering Experiment Station of the University of Illinois.

This bulletin is the second of a series of bulletins dealing with the magnetic, electrical, mechanical, chemical, and metallurgical properties of iron melted in a vacuum furnace. It was shown in Bulletin No. 72,

"Magnetic and Other Properties of Electrolytic Iron Melted in Vacuo," that iron of an exceptionally good magnetic quality could be produced in such a furnace. Bulletin No. 77 gives the results obtained by adding boron to pure iron. Small percentages of boron added are shown to improve the iron slightly while boron added in a sufficient amount to leave a measurable quantity combined with the iron has a decidedly detrimental effect upon the magnetic properties. The crystalline structure of the alloys is shown by means of numerous photographs.

Copies of Bulletin No. 77 may be obtained gratis upon application to C. R. Richards, Engineering Experiment Station, University of Illinois, Urbana, Ill.

HEAT ENGINEERING, by A. M. Greene; New York, 1915; 462 pages, 198 illustrations. Price, $4.

It is found that the average engineering text book is either too theoretical, without any consideration of the practical side of the subject, or else the other extreme is encountered wherein only the practical side is treated.

In the preparation of this book, the author has, by combining his own notes and the statements of the investigations and writings of others, succeeded in presenting not only a thorough discussion of the theory of applied thermodynamics, but has shown the practical application of the subject to everyday engineering problems in such a manner that the student is readily brought to a fuller understanding of the nature and application of heat.

Chapter I is a review of the principles of thermodynamics. Chapter II is devoted to heat engines, while Chapter III takes up the subject of heat transmission. The subjects covered in the succeeding chapters are air compressors, the steam engine, multiple expansion engines, steam nozzles, injectors, steam turbines, condensers, cooling towers, evaporators, internal combustion engines and refrigeration.

Higher mathematics is used extensively throughout the book, both in the presentation of the theory and in the solution of the problems.

LATHES: THEIR CONSTRUCTION AND OPERATION, by G. W. Burley; 224 pages, 200 illustrations; London, 1915. Price, 3/6 net.

In taking up the matter contained in this book, the reader gains good working descriptions of the various types of lathes as found on the present day American and English markets.

Before taking up the general subject of lathes, the author has endeavored to give an interesting history of the common turning lathe, followed by a classification of modern lathes.

Chapter IV takes up the subject of Hand-turning Lathes; Chapter V, Engines Lathes; Chapter VI, Turret Lathes, and Chapter VII, Vertical Lathes. Special Lathes are taken up in Chapter VIII, while Chapters IX, X, XI and XII are devoted to the subjects of Lathe Accessories, Lathe Cutting Tools, Lathe Work and Cutting Speeds and Feeds respectively.

HANCOCK'S APPLIED MECHANICS FOR ENGINEERS, by N. C. Riggs; New York, 1915; second edition, 441 p., 289 illustrations. Price, $2.40.

While this book has been primarily prepared for the technical school students, the practicing engineer will also find it helpful in his daily work.

In the preparation of this book the author has had in mind the fact that the average student finds much difficulty in seeing the applications of theory to practical problems and has therefore caused each new principle to be followed by a number of problems illustrating the practical application of that principle. In many cases these problems, which deal with matters that directly concern the engineer, are illustrated, thereby aiding the student in a clearer comprehension of the matter in hand.

An important change in this, the second edition, is found in the broader use of graphical methods. The graphical and analytical methods have been developed simultaneously and many problems are given to be solved by both methods. Use of the graphical methods has brought about the introduction of considerable new material, particularly in the construction of stress diagrams for trusses, and in the application of the equilibrium polygon to centers of gravity of plane areas, to weighted strings and linkages, and to bending moment diagrams.

Catalog Notes

TESTING V-NOTCH METERS, Engineering Leaflet 18, issued by the Harrison Safety Boiler Works, 3144 N. 17th St., Philadelphia, Pa., is a reprint of 2 papers on the V-notch weir as used in the Cochrane metering heater. One of these, by James Barr, describes at considerable length and detail the apparatus used by him and the results obtained in tests conducted at Glasgow University in 1907-09, by which he established the fact that with a V-notch weir the true discharge for given conditions could be determined within 1/3 of 1 per cent. The other paper, by W. S. Giele, describes a commercial testing apparatus of large capacity installed by the Harrison Safety Boiler Works for the purpose of carrying out an extensive series of tests upon V-notch weirs of different dimensions as actually installed in commercial meter chambers manufactured by them.

IT IS RECOGNIZED that the 2 great problems in soot removal are to do it often enough to minimize the waste, and to do it thoroughly enough to prevent destructive effects. In both these matters, the mechanical blower helps to solve the problem. Boilers are purchased on their rated horsepower capacity, but this capacity depends upon available heating surface, and if the heating surface be clouded with dirt and soot, a boiler costing $2500 may be doing only work which a $2000 boiler would do under favorable conditions.

If the engineer knows that his boilers are not in best condition, either because of long service or lack of care, and if the fuel is of such quality as to cause much soot, then the frequent cleaning necessary will be a burden. The mechanical blower can keep the boilers in the best possible working order, with no loss of time and slight effort, which will relieve the discomfort of the blowing down, and save time for keeping the rest of the plant in condition.

The saving of time in blowing down is second only to the saving in coal. Boiler surfaces are not exposed to cold draft while being cleaned, hence expansion and

contraction strains are not introduced, and the repair expense is, therefore, lessened. Where these expansion strains are frequently encountered by the boiler, as is necessary in frequent blowing down with dirty coal, likelihood of accident is increased and shutdowns for repairs and overhauling are multiplied.

In a booklet issued by the Diamond Power Specialty Co., of Detroit, Mich., called "Cutting the Cost of Producing Steam," some interesting figures are given as showing the saving by mechanical methods of soot blowing, these figures being compiled from actual tests made by skilled engineers. The saving shown is as follows: On a 500-hp. horizontal water tube boiler, $559.34 a year; on a 400-hp. Wickes boiler, $495.04; on a 500-hp. Stirling, $474.25; on 2 72-in. return tubular boilers, $440.22; on a 410-hp. hollow staybolt boiler, $622.51. The booklet gives not only these figures, but the method pursued in getting them, so that the proper way of determining the savings in any plant is readily seen. The booklet is available to any one application.

FROM KERR TURBINE CO., Wellsville, N. Y., we have just received Bulletin No. 51, entitled Economy Geared Turbines.

BLAST FURNACES and smelting plants, storage bins, material handling equipment and examples of other engineering construction performed by Arthur G. McKee & Co., Cleveland, O., are illustrated in Catalog No. 4.

PIPE REPAIR BOOK of 16 pages on steam joint clamps, valve reseating tools, boiler tube cutters, etc., was lately received from M. B. Skinner & Co., Distributors for James McCrea & Co., 558-562 Washington Blvd., Chicago.

GRAVITY SPIRAL CONVEYORS for lowering merchandise in packages, boxes, etc., are described and various installations are illustrated in a new catalog from Otis Elevator Co., 11th Ave. and 26th St., New York.

COMPASSES AND THERMOMETERS made by Taylor Instrument Cos., Rochester, N. Y., are illustrated in a recent publication which also contains interesting articles on the manufacture of thermometers, temperature in plants, etc.

KERR TURBINE CO., Wellsville, N. Y., has just issued Bulletin No. 52, describing and illustrating Economy steam-turbine-driven pumps for water supply, boiler feeding, fire service, circulating condenser water, circulating water in heating systems, draining mines, etc.

WESTINGHOUSE PORTABLE METERS for alternating and direct current are described in a 32-page circular, No. 1104.

Other recent circulars from the company are as follows: No. 1137, Watthour Meters for Alternating Current and Direct Current; Instruction Book No. 5071, Instructions for the Installation and Care of Westinghouse Integrating Wattmeter for Direct Current; Instruction Book 5054, Prepayment Watthour Meter; Folder No. 4133, Westinghouse Portable Standard Integrating Wattmeters; Descriptive Leaflet 3769, giving typical performance curves of Types C and OA watthour meters.

A CIRCULAR illustrating Laclede-Christy automatic stokers is being sent out by Laclede-Christy Clay Products Co., St. Louis, Mo.

IN A PAMPHLET on Houses for Mining Towns, published by the Department of the Interior, Bureau of Mines, as its Bulletin 87 of the Department's publications, much valuable information is given in regard to the location of buildings, sanitation, arrangement of houses and lots for appearance and convenience, and proper details of construction to give good economy, both in the construction and in the upkeep. While much of the material pertains especially to mining towns constructed in large numbers by a company contractor, there is much of the information which is of value to anyone in the construction of a dwelling or of a small factory building. Copies of the bulletin may be had by application to the Bureau of Mines, Washington, D. C., asking for Bulletin 87, or if the free edition has been exhausted, from the Superintendent of Documents, Government Printing Office, Washington, D. C., at the price of 15 cents.

MANAGERS OF FOUNDRIES and larger repair shops where there is sufficient welding to warrant the installation of any apparatus for this purpose will be interested in Bulletins 48,904 and 48,905, just issued by the General Electric Co., and devoted to the subject of Electric Arc Welding and Arc Welding Apparatus.

Bulletin 48,905 illustrates and describes the General Electric Co.'s apparatus for electric arc welding. Both stationary and portable apparatus are described.

Bulletin 48,904 takes up the general subject of electric arc welding and describes the 3 processes by means of which welding may be done. It also refers to the welding equipments, materials, notes the advantages to be derived from this process, and mentions special applications of electric welding.

A. S. CAMERON Steam Pump Works, 11 Broadway, New York, has published the following among recent bulletins: No. 104, superseding Nos. 102 and 103, on the subject of Cameron Pumps No. 153, Cameron Centrifugal Pumps for house service; No. 151, Cameron Turbine Centrifugal Pumps; No. 300, Cameron Triplex Pumps.

REPRINTS IN PAMPHLET FORM of the article on the Meriam Steam Process, which appeared some time ago in Practical Engineer, have been made by the Bruce-Macbeth Engine Co., of Cleveland, O., which manufactures vertical, multicylinder gas engines, and controls the Meriam process. Copies of these reprints may be had by addressing the Bruce-Macbeth Co.

THE GENERAL ELECTRIC CO. has recently issued Bulletin No. 44,004, which forms an ordering catalog devoted to railway line material for direct suspension. This publication covers practically everything in line material for this method of suspension, save poles and wire. The parts are illustrated and each illustration is accompanied by the proper catalog numbers. The prices are not included. The bulletin contains also miscellaneous data relative to construction, overhead material per mile, general data on the use of solid copper wire and copper cable, dimensions of grooved trolley wire sections, etc.

POLE LINE HARDWARE is the title of Catalog Section DS846, issued by the Westinghouse Electric & Mfg. Co. This catalog gives a complete list, together with illustrations, of the different accessories used in connection with transmission lines.

THE OPERATING ENGINEER who wants to know what a pump will do and how it will fit his conditions will be interested in a Reference Bulletin just issued by Royal C. Wise, No. 9 So. Clinton St., Chicago. This bulletin specially refers to electrically driven centrifugal pumps and contains new data regarding bilge and sump pumps, house pumps, gasoline driven pumps and other appliances for handling water about a power plant.

SPRAYS FOR COOLING condensing water are described and typical installations are illustrated in a pamphlet from Spray Engineering Co., 93 Federal St., Boston, Mass.

Washing and Cooling Air for Steam Turbine Generators is the title of another pamphlet recently received from the company.

THE TURBO-GEAR, made by Turbo-Gear Co., Industrial Bldg., Baltimore, Md., is described in Catalog A. This can be used either as a speed reducing or speed increasing gear and will run either right or left-hand with the same efficiency. The driving and the driven shaft rotates in the same direction. They are being made in 7 different standard speed ratios.

IN BULLETIN 42,300, recently issued by the General Electric Co., is described that company's line of small direct-connected generating sets of sizes ranging from 2½ to 75 kw. While ordnarily designed to meet the severe conditions of marine work demanding light, compact and durable sets of close regulation and quiet operation, they are also well adapted and used extensively for both power and lighting in isolated plants, and as exciters for alternating-current generators in central station work. Both the engine and the generator are described in the bulletin in considerable detail.

DESCRIPTIVE LEAFLET No. 3698-A, from the Westinghouse Elec. & Mfg. Co., covers motors for linotype and intertype machines in which the class of motors designed for this application is described and illustrated.

Descriptive Leaflet No. 3770 deals with Westinghouse Cam Limit Switches. This switch finds a ready adaptation to elevators, skip hoists, mine hoists, steel mill machinery and wherever it is necessary to confine the travel of a moving mechanism within certain predetermined limits.

Small Motors No. 22 is devoted to a description of Westinghouse Type AR single-phase motor. Complete and detail views of this type of motor are shown and its characteristics thoroughly described.

The A B C of Automobile Battery Charging, Folder 4201, covers in a complete and concise manner the use of rectifier outfits for charging storage batteries. The accessories, such as time switches and meter panels, are also described and illustrated.

Electric Vehicle Battery Charging by means of Motor-Generator Set is also thoroughly described and illustrated by means of Leaflet No. 3679, in which special mention is made of the switchboard designed for this class of work.

PRACTICAL ENGINEER

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All copy should be received at Chicago office 18 days before date of publication.

Circulation of this issue, 22,500.

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537 S. Dearborn Street
Chicago

Position Wanted

POSITION WANTED—As assistant engineer, experienced; I. C. S. student; best references; strictly sober, hold first class license; will consider small salary if advanced as merited. Address Robert Pieper, Bloomington Prairie, Minn. 5-1-1

POSITION WANTED—By young man, age 21 as oiler or helper in power plant. A. S. C. graduate, electrical course. Some experience small gas engines. Would work a while for experience. Address O. W. House, Rush Springs, Okla. 4-1-3

POSITION WANTED—Man 39 years old, long experience with electric light and water works plants. Five years manager on plant. Strictly sober. Best references. Wants position as manager plant. Texas or Oklahoma preferred. Address C. X., 809 Austin Ave., Brownwood, Texas. 6-1-1

POSITION WANTED—By engineer in medium sized power plant, or large coal mine. Have Illinois license; 7 years' experience with steam engines and boilers. Some experience with electricity. Good habits. References. 24. Illinois preferred. Address W. E. Rohline, Box 224, Farmington, Ill. 6-1-1

POSITION WANTED—Steam engineer wants position in water works or mill plant. 33 yr. old. Married. Sober. Best of references. Iowa preferred. Address F J. Kirkpatrick, Indianalo, Iowa. 6-1-1

POSITION WANTED—By engineer, 8 yr. experience with steam and electric. Understand gas engines and refrigeration. Temperate, reliable, married man. Member N. A. S. E. Address W. H. Snyder, 53 Brown St., Hartford, Conn.

POSITION WANTED—By engineer with years of experience in ice and electric light plants. Understand both a.c. and d.c. machines. Am a graduate of one of the best colleges in Middle West. A1 references Ezra D. Dumas, Clarinda, Iowa. 6-1-1

POSITION WANTED—As chief engineer in a small or medium sized plant. Twelve years' practical and technical experience in operation and maintenance of steam, electric refrigerating, pumping and condensing equipment. First class license. Married; age 30. Employed. Address Practical Engineer, Box 392, Chicago, Ill. 6-1-1

POSITION WANTED—By young man with 10 years' practical experience from boiler room up. Hold first class Massachusetts engineer's license. Will go anywhere. Am total abstainer and can furnish A1 references. Address Practical Engineer, Box 393, Chicago, Ill. 6-1-1

POSITION WANTED—By licensed engineer, age 30. Good mechanic. 10 yr. experience. Can furnish A No. 1 references. Chicago preferred. Address Box 390, Practical Engineer, Chicago, Ill. 6-1-1

Wanted

WANTED—Resident subscription agents in the following cities: Atlanta, Ga.; Cincinnati and Columbus, Ohio; Kansas City, Mo.; Los Angeles, Calif.; Louisville, Ky.; Newark, N. J.; New Orleans, La.; Portland, Ore.; St. Louis, Mo.; San Francisco, Calif.; Washington, D. C. This is an excellent chance for a hustler, who is familiar with power plant conditions, to turn his spare time into dollars. To such a one we offer a Real Opportunity. Write Subscription Department, Practical Engineer, 537 S. Dearborn St., Chicago, Ill. tf.

FREE ENGINEERING BOOKS and power plant tools and specialties for securing new subscribers to Practical Engineer. A dandy chance for the engineer with a little spare time to get some fine premiums. Send for free descriptive circular and terms. Address Practical Engineer, Subscription Department, Chicago, Ill.

WANTED—Representative to cover territory more thoroughly. Boiler room necessities. Liberal commissions. Old established house. Apply by letter. H. F. Maurel, 534 W. 22nd St., New York City. 4-1-6

WANTED—Stationary engineers to handle pump counter; nothing like it on the market; large commission. Address Box 396, Practical Engineer, Chicago, Ill. 6-1-2

Help Wanted

WANTED—Agents on commission to sell our Shaking Grates. We will install grates on trial or put in on test at our expense with any grate made. Address Armstrong Mfg. Company Springfield, Ohio. tf.

WANTED—Agents handling engine and boiler-room specialties in every section for side line paying large commissions. Give experience, line carried, and territory covered. Address Practical Engineer, Box 381, Chicago, Ill. tf.

For Sale

FOR SALE—Machinery. All sizes new and second-hand Pulleys, Belting, Shafting, Hangers, Couplings, Pillow Blocks, Collars etc. Passman Bros., 28 and 30 S. Green St., Chicago, Ill. 3-15-6

FANS AND MOTORS—For sale a large number of A.C. and D.C. electric fans, new and at prices from $6.00 each upwards. All styles, including oscillating, ceiling, desk, etc. Motors alternating 1/12 to 7½ H.P., one, two and three phase. Motors, direct current 1/40 to 30 H.P. for all voltages. Generators also. Fidelity Electric Co., Lancaster, Pa. 4-1-4

FOR SALE—Grobert Swiss Files are the standard of excellence in files, and have been for over 100 yr. We send, postpaid, as an introducer, 48 files especially adapted for tool makers and machinists on receipt of $5.00. This is a chance to get a set of files you'll appreciate and we'll get future orders. Montgomery & Co., 101 Fulton St., New York, N. Y. tf.

Patents and Patent Attorneys

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY—Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for search. Watson E. Coleman, Patent Lawyer, 624 F St., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had, and the exact costs. Send for full information. tf.

PATENTS—Send sketch for free search and reports. Books on patents and book of reference letters sent free. John S. Duffie & Co., 612 F St., Washington, D. C. tf.

A. P. CONNOR, consulting electrical and mechanical engineer, attorney-at-law and solicitor of patents and trade-marks, 121 Carroll St., S. E., Washington, D. C. tf.-x.

PATENTABLE IDEAS WANTED—Send for three free books. R. B. Owen, 28 Owen Bldg., Washington, D. C. tf.

Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages, edited by University of Tennessee, will be mailed every subscriber sending in NEW subscriptions (not your own) to Practical Engineer. Gilt edges; bound in leather.

Miscellaneous

ENGINEERS, DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

Sparks From The Advertising Pages

A FIVE REEL THRILLER

"We are coming, Father Abraham, six hundred-thousand strong."

The modern, up-to-the-minute interpolation of that old Federal slogan might well read:

"We are coming, Father Dearborn, more than fifteen-thousand strong."

Not as the rush that marked President Lincoln's second call for volunteers—not as the recent mad and rampant scramble up the heights of the Carpathians—but as the peaceful gathering for individual good and national betterment of thousands of business men to the Eleventh Annual Convention of the Associated Advertising Clubs of the World, in Chicago, June 20th to 24th.

It has been prophesied that it will be the largest business convention ever held, with the greatest multitude of people ever assembled for one business purpose.

A real five-reel thriller—one reel a day.

There will be oodles of unique features that will make a three-ring circus and all the pink lemonade and peanuts seem as tame as a quack medicine show in, comparison.

A gigantic night pageant, the uniqueness of which will never have been seen before, is scheduled for Monday night, June 21st.

It will be essayed and "Essanayed" from ocean to ocean, and from the gulf to the lakes.

Advertising will be glorified. Well known trade mark figures will be cheered by hundreds of thousands. Mayor Thompson has proclaimed this convention period "Advertising Week." It will be developed and fostered by the merchants and the press. A Moonlight Excursion—a two-act show called "Advertising Frolix"—a big baseball game—are a few of the features of entertainment.

Conditions permitting, President Woodrow Wilson and Secretary of State, William Jennings Bryan will make addresses. Other prominent speakers are also on the program.

Of course, there will be advertising clinics galore.

The far-reaching importance and the many benefits of this great convention cannot be overemphasized for is not our civilization — our freedom—our prosperity gauged according to our ability to distribute the products of manufacture and of invention?

Contrast the quality of our civilization to that in practice across the pond. Even at this writing comes the official report that another country has been involved in the fracas. With a war incomparable to anything in history raging abroad—with new complications arising each day among the foreign countries because of a lot of diplomats who cannot diplomat, we, a peaceful nation, are holding a gigantic convention to disseminate the gospel of human service instead of human destruction.

Nor is this country witnessing any such panic as it experienced eight years ago when its commercial life was temporarily crippled in time of profound peace.

May we fully appreciate the fact that the affairs of our nation during this crisis have been and are still in the hands of those who can preserve peace with honor, even amidst the selfish claques and the clamorous back-biting jingoes who have tried to use this nation to bolster up one side of the great European Argument.

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